SMITHSONIAN

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VOL. 107

"EVERY MAN IS A VALUABLE MEMBER OF SOCIETY WHO, BY HIS OBSERVATIONS, RESEARCHES, AND EXPERIMENTS, PROCURES KNOWLEDGE FOR MEN"—SMITHSON

(PUBLICATION 3949)

CITY OF WASHINGTON
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BALTIMORE, MD., U. S. A.

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A. Wetmore,
Secretary of the Smithsonian Institution.

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THE ETHNOGEOGRAPHIC BOARD

BY
WENDELL CLARK BENNETT

(PUBLICATION 3889)

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PREFACE

The Ethnogeographic Board was established in June 1942 by the National Research Council, the American Council of Learned Societies, the Social Science Research Council, and the Smithsonian Institution. A printed brochure stated the primary purpose: "to make readily accessible to Washington military and war agencies such specific regional information and evaluated personnel data as may be available to the sponsoring institutions and the numerous other governmental and outside scientific organizations with which they are affiliated or in contact." The Board consists of a policy and advisory body, the members of which are selected by the four sponsoring institutions, and a Director and staff with offices in the Smithsonian Institution, Washington, D. C.

The Ethnogeographic Board is now entering its fourth year of activity and will continue as long as its services are needed in the war emergency. The Sponsors have requested that the Board prepare, while still in operation, a historical account of the work, an appraisal of the experience, and constructive suggestions for the consideration of the Sponsors as to the most effective ways of organizing the scholarly and scientific resources, which they represent, for public service.

Such an assignment presents its difficulties in spite of the short time span and relative simplicity of the organization. Obviously, the history is not intended as an apology. In fact, the preparation of the pocket booklet "Survival on Land and Sea," of which almost one million copies were distributed to the armed forces, would in itself justify the Ethnogeographic Board's existence. Furthermore, neither the Sponsors nor the Board members consider the organization one of unique importance since they are well aware that it was but one of many efforts to make the country's scholarly and scientific resources available for emergency use. However, in this lies the importance of a historical analysis, since the Board can be considered, in a very real sense, a sample of broader activities.

The Ethnogeographic Board is an example of a service organization, a clearinghouse for Government needs and academic knowledge. Service was the keynote, both by mandate and by practice, and consequently, the major emphasis in this analysis will be placed on that aspect. Before a proper evaluation of this service can be made, it is necessary to review the setting, the intellectual and physical environment, in which the Board operated. Washington in wartime was in itself a factor of major importance.

The body of this report consists of a somewhat detailed account of the activities of the Ethnogeographic Board. No attempt has been made to follow a chronological order, except when sequence is needed to explain some action, or to illustrate speed. The approach is frankly topical and, after each topic is described, an analysis and evaluation is added. Were the techniques and accomplishments effective or ineffective? What techniques were not employed and why? Such a detailed presentation is justified on the grounds that the actual actions of the Board form the documentation on which this study is based. If minimized, the report becomes little more than the personal reflections and prejudices of its author.

An over-all appraisal follows the topical description. The service and research features, as well as some of the specific techniques and materials, are reviewed in the light of their general usefulness for future emergencies and for other than wartime situations. For example, dinner conferences, problem conferences, liaison officers, surveys, and interviews are all techniques which have wide application. Likewise, certain materials such as the Area Roster, the area bibliographies, the survival library, and the area reports might be worth while preserving and elaborating.

The Board is more than an illustration of an emergency service organization. For example, it was also a joint committee of the three Councils, cooperating, in this case, with the Smithsonian Institution. Implicit in this review is, then, an evaluation of the effectiveness of joint committees. The Ethnogeographic Board was characterized, as its name implies, by the area approach. Since area versus discipline is a question of considerable interest, it seems worth while to emphasize the area techniques and materials assembled by the Board.

Finally, the future, both immediate and distant, must be faced. This can be treated in three ways. First, the experience of this Board should serve as a basis for determining the nature and function of a similar organization in the next emergency. Second, the efforts of the Board to supply needed information to the Government war agencies pointed up many lacunae in area materials, organized knowledge, and trained personnel. These demand serious consideration by both academic institutions and Government agencies. Third, the usefulness of an organization similar to this one in the immediate postwar period merits discussion. Insofar as suggestions about the future are derived from this analysis, they are placed in the final chapters. Other suggestions, formulated independently by the author, have been submitted directly to the Board and the Sponsors.

The task of going through the extensive files, reviewing the record, and what lay behind it, evaluating the successes and the failures, has been possible only because of the whole-hearted cooperation of the staff, the Board members, and the Sponsors. As a Board member myself, and a personal friend of everyone involved, the problem of maintaining an objective attitude has not always been easy. However, every participant has insisted that artificial courtesy should not spoil the usefulness of the report. If then, I speak of the Board largely in the past tense, it is only because that is the period covered, and not for any lack of appreciation of the continuing activities. Likewise, if I seem to judge harshly at times, the victim's consent is implied, although the opinion is wholly my own.

WENDELL C. BENNETT,
New Haven, Connecticut,
August 1, 1945.

ADDENDUM

This history when first submitted covered the activities of the Ethnogeographic Board up to June 1945. Since that time the Board has been formally disbanded, as of December 31, 1945, although certain unfinished commitments are still to be completed. The first 3 years were those of greatest activity, and consequently a complete revision of the history does not seem necessary. However, revisions have been made where needed to bring the activities up to date.

BOARD ORGANIZATION

SPONSORS	American Council of Learned Societies. National Research Council. Smithsonian Institution. Social Science Research Council.
COOPERATING WITH	Committee on African Anthropology. Committee on the Anthropology of Oceania. Committee on Asiatic Geography. Intensive Language Program. Joint Committee on Latin American Studies. Smithsonian War Committee.
DIRECTORS	William Duncan Strong. Henry B. Collins, Jr.
RESEARCH ASSOCIATES	Elizabeth Bacon. Homer Barnett. Henry B. Collins, Jr. William N. Fenton. Frank H. H. Roberts, Jr.
RESEARCH CONSULTANT	Raymond Kennedy.
CONSULTANTS	J. M. Cowan. Robert B. Hall. Melville J. Herskovits. George Peter Murdock. Douglas Whitaker.
BOARD MEMBERS	Carl E. Guthe (chairman). Wendell C. Bennett. Isaiah Bowman. Carter Goodrich. John E. Graf. Mortimer Graves. Robert B. Hall. Wilbur A. Sawyer. William Duncan Strong.
SPONSORS' REPRESENTATIVES	Charles G. Abbot. Robert Crane. Ross G. Harrison. Waldo G. Leland. Alexander Wetmore. Donald Young.

THE ETHNOGEOGRAPHIC BOARD

By WENDELL CLARK BENNETT
Yale University

BACKGROUND PROBLEMS

Wartime Washington

For the millions who milled around Washington in the first half of 1942 no statement about the fabulous confusion could ever be adequate and would never be necessary. In judging many of the service activities of the Ethnogeographic Board, however, the chaotic environment must be kept in mind. This was not a period of calm deliberation. Everyone rushed first, and questioned where he was going afterward. The sudden mass increase of population created a housing shortage, a restaurant shortage, a transportation shortage, a service shortage. All this was added to a day of office frustration.

New agencies were created overnight and old ones were expanded beyond capacity. Mandates were vague and overlapping. Competition was keen between agencies and within agencies. Experts were rushed from their calm academic security into the maelstrom. The process of "leveling" was elaborated, so that a man in one agency, in order to communicate with a colleague in another, had to send his message up to his top-ranking official, who transferred it to a correspondingly high official in the other agency who in turn let it "level" down to the man who should have received it directly. In the war fervor each agency started a system of classifying its documents—any document—as confidential, secret, supersecret. The mad scene was popularly labeled the "War of Washington" and doubtless will become the subject matter of many a roving reporter's personal reminiscences. It was both ironic and pathetic. There were many opportunists, but there were a vastly greater number of the genuinely sincere who wanted to be of service in the prosecution of a war in which V-day was not yet visible on the horizon.

The Ethnogeographic Board, unlike many other agencies, found operation in wartime Washington a stimulating challenge. Fortunately, it had certain concrete advantages over the others. Though a new organization, it was housed in the Smithsonian Institution building and staffed by Smithsonian personnel familiar with the Washington scene. Being non-Governmental it was outside most of the competition and suspicion. Its services were open to all agencies. Since it had no fixed place in the Government hierarchy, it could receive a general or a private, the chief of an agency or a junior research assistant. Withal, however, many of its actions and methods seem meaningless if the Washington environment is forgotten.

Research versus Action

The Ethnogeographic Board, as an intermediary between academic institutions and Government agencies, faced a second general problem, that of research versus action programs. In general, the emphasis of universities, foundations, councils and scholarly institutions is on research, or training for research. Government agencies, on the other hand, are engaged in the execution of action programs. Undoubtedly the careful investigation and ordering of facts carried on in many a Government agency is as much entitled to the term "research" as is the most pedantic university program, but that the two differ in orientation seems clear. The Government interests lie in the applied field; academic scholars prefer placing application in a secondary category, if they recognize it at all.

The Board was, theoretically, supposed to adjust these two approaches. Although not in itself a research organization, it was an agency for the procurement of such information. In order to do this it had the dual task of translating the Government action needs into terms which the academic researcher could understand, and likewise, of presenting the research materials in a form which would make them useful for the Government agencies. In part this also involved anticipating Government needs, and following up "quick" reports with others of a more considered nature. Actually, little was ever done about this last point, but the need is nonetheless real. Hasty reports produced in the heat of an emergency have the tendency of gaining prestige by the mere virtue of remaining unreplaced by anything better in somebody's file.

The Ethnogeographic Board is but a junior member of the corps of agencies, Governmental and non-Governmental, which have been struggling with this vitally important question of the integration of non-Federal research and Government needs. The three Councils and their numerous committees, the National Resources Planning Board, the Office of Scientific Research and Development, and many another agency have worked out some techniques. Many Government bureaus have appointed professional committees and consultants, and hired professional personnel for this purpose. The Government's role in the support of academic research is still a much debated issue.

Area Approach

"Ethnogeography," according to the Board's own definition of its somewhat cumbersome name, "is the study of human and natural resources of world areas." In its application for financial support, the Board restated its function ". . . to furnish to Governmental war agencies, military and civilian, needed information of all sorts relating to any areas outside the United States where military, economic, or other action is carried on or planned." This brings up another major problem faced by the Board, namely, that Government agencies, particularly the military, operate in terms of areas, while universities, councils, and foundations are organized by disciplines. Again it was necessary to translate the discipline knowledge into the geographic categories used by the Government.

Since the beginning of the war there has been a marked increase in area consciousness on the part of academic institutions, but at the time of the founding of the Board the problem was really acute. Before 1940, only the American Council of Learned Societies, among the three research Councils, had area committees. These were concerned largely with language and literature, although some, like the Committee on Latin American Studies, were truly cross-disciplinary bodies united by an area interest.

Some disciplines, such as history and government, have long recognized area subdivisions, even though these tend to be fixed by tradition and rarely achieve world coverage. Likewise, some fields of study are by their very nature more aware of areas than others. Most of the natural historians, particularly those in museums, have an area approach. Among the social sciences, geography is the most logical leader for the area approach in spite of the fact that it has so far failed to develop many specialists. Because of its interest in "primitive" peoples, anthropology has had many specialists with foreign-area experience. Previous to the area programs in the universities, sociology, political science, and economics largely ignored the area approach.

On the other hand, many of the Government departments, like Commerce, Agriculture, and State, have long maintained foreign-area divisions and staffed them with area experts. In fact for future discussions, it is interesting to remember that the foreign-service personnel of the Department of State has debated the issue of area versus professional specialty for years—a problem which is only now being considered by universities.

Since 1940 most of the war-emergency agencies have had area subdivisions. The Office of the Coordinator of Inter-American Affairs is the only one devoted exclusively to one area, but others, like the Office of Strategic Services, the Foreign Economic Administration, and the Office of War Information, attempt a world-wide coverage. The results of this increased area emphasis, added to the demands of the armed forces, placed a real strain on the supply of area specialists and made the work of the Ethnogeographic Board even more difficult by removing many of its chief sources of information.

Wartime Washington, research versus action, and area versus discipline are three of the broad background problems which confronted the Ethnogeographic Board. The more local and immediate problems are taken up in the detailed review of the actual operations of the Board.

FOUNDING OF THE BOARD

The founding of the Ethnogeographic Board was not the result of a sudden flash of inspiration in the minds of the Sponsors. Instead, the idea germinated in a number of divergent sources, all of which contributed to the formation of the final organization. The immediate roots of the Board reach back to prewar days, and probably the intellectual concept could be traced into the deep past. For the present purpose, the history can be confined to a brief review of the eight groups which made the most substantial contribution. The eight organizations do not form a pyramid capped by the Ethnogeographic Board, nor can their contributions be aligned in a strictly chronological order. Some of the eight no longer exist, others are still flourishing.

Committee on Latin American Anthropology

In December 1940 a group of anthropologists interested in the Latin American field held a conference which resulted in establishing a committee of the National Research Council. Although prewar, the committee's activities reflected not only the increased interest in Latin America but also a desire to integrate professional research and personnel with Government programs.

The committee at once began to assemble a personnel file of professional anthropologists in the United States who had worked in Latin America. Each individual was rated, by each committee member, on linguistic ability, teaching ability, and suitability for a number of type jobs which the committee's survey had indicated as potential outlets for trained personnel. (See Appendix B1 for a sample.) This file was confidential, by its very nature, but was used to furnish selected lists of specialized personnel in answer to requests from many Government agencies. A somewhat similar roster of Latin Americans interested in anthropology was also assembled, but in this the rating formula was not applied.

Other activities of this committee were more academic, such as a survey of research activities, and two reports on research needs. The chief contributions to the formation of the Ethnogeographic Board were the concept of area committees in anthropology, the rated personnel roster, the idea of service to Government, and the usefulness of liaison representatives. Shortly after the formation of the committee its activities were eclipsed, although not entirely eliminated, by the Joint Committee on Latin American Studies.

Joint Committee on Latin American Studies

In March 1942 the National Research Council, the American Council of Learned Societies, and the Social Science Research Council coordinated their Latin American interests by establishing a Joint Committee. This was the first joint committee of the three Councils, although the Latin Americanists had been organized since 1935 as a committee of one, and later of two, of the Councils. The old committee, among other things, had published the Handbook of Latin American Studies, a cross-disciplinary bibliographical guide. The Joint Committee continued the cross-disciplinary tradition as demonstrated by its first membership which represented anthropology, psychology, sociology, history, economics, geography, language and literature, and the arts.

The Joint Committee had many of the traditional academic interests in research, publication, tools of research, education and specialized personnel. However it was also given a special mandate as follows:

> The Joint Committee is prepared and willing to serve as an advisory agency, within its competence, to the various agencies of the Government, and to assist such agencies in the promotion of inter-American intellectual and cultural relations and in the planning and execution of projects.

This mandate led the committee rather deeply into certain Government departments where its advice was offered seriously, although not always accepted in the same spirit.

The Joint Committee cooperated with the Ethnogeographic Board without losing its independence. It initiated the pattern of committees of the three Councils, and showed the practicality of uniting disciplines by their area interests. Its Government experiment served as a warning to the Board that proffered advice, be it ever so sound, is seldom accepted or appreciated, and leads to suspicion and resentment not only from the receivers, but also from the professional colleagues of the advisory body.

Intensive Language Program

The American Council of Learned Societies, since it represents the humanities, has a natural interest in language and literature, both area subjects. The Council has long supported such regional committees as those on Chinese, Japanese, Indic and Iranian, Near Eastern, Arabic and Islamic, and Slavic studies. The Intensive Language Program was directed toward the intensive teaching of many languages in anticipation of a real Government need. University programs were organized for teaching officers of the armed forces such languages as Russian, Chinese, Japanese, Malayan, Burmese, Thai, and Swahili. The great success of this program forms one of the outstanding achievements of scholarly efforts in wartime.

The existence of the Intensive Language Program allowed the Ethnogeographic Board to concentrate on the geographical and cultural aspects of area and to transfer language questions to its collaborator. This was more than just a practical working arrangement which developed with time. The complementary relationship of the two programs was clearly considered at a meeting in March 1942, before the Board was actually established.

Committee on the Anthropology of Oceania

In January 1942 a group of anthropologists interested in Oceania, inspired by the Committee on Latin American Anthropology and fully cognizant of an opportunity to be of service to the war, established a committee of the National Research Council. This group was aware of the need for integrated studies of world areas, and their application to the National Research Council actually requested that a special committee on anthropological areas be established, with an immediate subcommittee on Oceania. The over-all committee was not accepted at this time, but the idea was fermenting.

The Oceania committee immediately started a personnel file. This was not modeled on the Latin American committee's limited and highly evaluated list of anthropologists, but was extended to include other disciplines as well as nonprofessionals. A mimeographed form was devised (Appendix B2) which emphasized the specific Pacific Islands with which the individual was familiar, the documentary or illustrative materials which he possessed, the languages which he knew, and his proficiency in them. Each individual was asked whether he would be willing to fill out a follow-up, specific-knowledge report, or be willing to be interviewed. He was also asked to supply the names of others who might have valuable experience and knowledge of the Pacific. This questionnaire form, considerably simplified, was adopted later by the Ethnogeographic Board in building up its own roster.

The assembled personnel data were mimeographed in six installments entitled: "Personnel List of Oceania," and turned over to the Ethnogeographic Board for distribution. Later, the committee sent out a follow-up questionnaire asking for detailed information on geography and peoples of the Pacific (Appendix B3).

The chairman of the Oceania committee, George Peter Murdock, was also the director of the Cross-Cultural Survey at Yale so that the activities of the two organizations were linked. The Survey had been engaged for many years in getting published data on the primitive tribes of the world, and in processing and filing them systematically. When the war started the Survey approach was enlarged to include more than the primitive and strictly anthropological, and the efforts of the staff were concentrated on the Pacific Islands, particularly Micronesia. Together, the committee and the Survey prepared a number of factual accounts about specific islands and island groups which again were distributed by the Ethnogeographic Board and this collaboration continued even after the Survey was taken over by the Navy. On the whole, the Oceania committee deserves great credit in furnishing materials and setting patterns of procedure for the Board.

Committee on African Anthropology

Shortly after the Oceania committee was established a similar one on Africa was appointed by the National Research Council. This group built up "The Personnel List of Africa" which was mimeographed in six installments and distributed by the Ethnogeographic Board. The Africa committee worked on a tribal bibliography, a tribal location index, and sought out native informants in this country for use in an intensive language study. The Africa committee was also an important contributor to the Board.

Ethnographic Board

With three anthropological area committees already operating in the National Research Council, and a fourth on Japan, China, and India contemplated, the idea of over-all coordination, first proposed by the Oceania group, was again brought forth. Carl E. Guthe, vice chairman of the Division of Anthropology and Psychology, called an organizational conference to consider the formation of an "Ethnographic Board." This body was to consist only of anthropologists and be located at the National Research Council. It was to act as an over-all organization for the regional subcommittees, so as to systematize procedures and prevent unnecessary duplication of records and efforts. It was also to serve as a clearinghouse for inquiries upon ethnographic subjects referred to the Council.

The organizational meeting was held in March 1942 and was attended by nine anthropologists, including the chairmen of the established area committees. The functions of an Ethnographic Board were discussed at length, and there seemed little doubt that activity would not be wanting. Three important requirements were faced. First, the need for adequate financing, preferably from a non-Federal source. Second, the need for an executive secretary who would establish the necessary connections in Washington in order that the work of the Ethnographic Board would not be confined to the four walls of the Council. Third, the need for integrating the activities of the three Councils, since anthropology is represented in each. William Duncan Strong was recommended for Executive Secretary, and Carl E. Guthe was elected Chairman. They became, later, the Director and Chairman, respectively, of the Ethnogeographic Board.

The Ethnographic Board was duly appointed by the National Research Council but never functioned because of that all-important question of financing. Getting funds from foundations needs backing. Two Councils are better than one, and three are better than two, at least, it was so reasoned at the organizational meeting. Since the Directors of the three Councils were accustomed to meet informally from time to time, it was decided to discuss the monetary problem with them. But three Councils also have bigger ideas than one, so, as can be anticipated, ethnography (the study of peoples) was laid on the flaming altar and ethnogeography (peoples plus land) emerged from its ashes. However, one other organization must first be considered before the history goes on, since it furnished the fuel for the burning flames.

Smithsonian War Committee

On the last day of March 1942 the Smithsonian Institution called a meeting of the staff for a discussion of the role of the Smithsonian in the war effort. Out of this meeting came the Smithsonian War Committee. One of its first acts was to assemble a roster which recorded the world travel and the special abilities of the Smithsonian's staff. A second action started a series called "War Background Studies" of which 21 well-illustrated and popularly, although accurately, written numbers have appeared which cover many areas of the world. Official liaison was established with Army Intelligence. In fact, the committee started out to do many of the things later taken over by the Ethnogeographic Board.

At one of the formative meetings of this committee a report was made on the proposed Ethnographic Board of the National Research Council. The Smithsonian considered the advantages of cooperating with this body and decided to offer it office space as well as a salary for the Director, particularly if it were Dr. Strong who had for many years worked for the Bureau of American Ethnology. Dr. Strong was consulted and agreed to accept provided the merger could be effected.

Conference Board of Associated Research Councils

The Conference Board did not become a formal organization until March 1944, but previous to that date informal meetings of the Directors of the three Councils were held frequently to discuss problems of mutual interest, and to keep informed on each other's activities. In June 1942 the Directors, together with the Secretary of the Smithsonian Institution, met to discuss the financial problem of the Ethnographic Board. The discussion was not so confined.

The objection was raised to limiting such a Board to one discipline, namely anthropology. If it were to be interdisciplinary, then the sponsorship of all three Councils would be logical, since collectively they represented the earth and biological sciences, the historical and social sciences, and the humanities. There would be an advantage, particularly from the point of view of the Government, in having a single agency to which queries and requests for assistance could be addressed. All agreed that the enlarged concept was definitely superior.

The offer of the Smithsonian Institution to provide the salary of the Director, office space, and other technical assistance, made the establishment of the Board an immediate reality. The Councils agreed to provide a sum of $6,000 for the initial operating costs, and to take up the question of applying for Foundation support after a short trial period. In brief, the following agreements were reached:

1. That the Board was a joint committee of the three Councils and the Smithsonian Institution.

2. That the name was to be the Ethnogeographic Board.

3. That the National Research Council was to act as fiscal agent.

4. That the old Ethnographic Board was to be discontinued, and the jurisdiction of the Ethnogeographic Board shifted from the Division of Anthropology and Psychology to the Executive Board of the National Research Council.

5. That the Joint Committee on Latin American Studies, the committees on the anthropology of Oceania and Africa, the Intensive Language Program, and the Smithsonian War Committee should not be discontinued or reduced to subcommittees of the Board, but should be considered as cooperating organizations and so listed on the letterhead.

6. That William Duncan Strong was to be Director of the Ethnogeographic Board, with offices located in the Smithsonian Institution.

7. That the Board itself would be interdisciplinary in character and would act as an advisory and policy-making body for the Directorate.

8. That the Directors of the four sponsoring institutions would serve as ex officio members of the Board and that other Board members would be chosen jointly by the four Sponsors as "representatives of varied important human disciplines, on the basis of their familiarity with one or more geographical regions and their experience and associations." (From the brochure of the Ethnogeographic Board.)

Thus on June 16, 1942, the Ethnogeographic Board was settled in its Washington offices and ready to begin business.

Ethnogeographic Board

The true need for an organization of this type is implicit in the historical summary of its development. That the Board performed many useful services and more than justified its existence has been stated previously and will be repeated frequently in this account. The question raised here is merely whether the same results might have been accomplished in a simpler way, and whether, in a future emergency, a board with similar organizational structure would be needed.

The Board had an impressive paper backing. The myriad resources of the Smithsonian Institution, the experience of the three Councils plus their varied committees, the activities of the cooperating committees, and an active group of Board members, theoretically selected for their versatility and ingenuity, were all at its command. Was such an array necessary for a service job?

The answer to this question must be in the affirmative. It will be pointed out later that some of the Board's connections never got beyond the paper stage, and that the Board itself failed to utilize, for one reason or another, its full potential backing. Many of the accomplishments of the Board could have been realized by the Smithsonian, one Council, or a simple combination of the cooperating committees. In fact, for the sake of discussion, it could be admitted that the total work of the Board might have been performed with comparable success with a less elaborate background structure. In spite of all this, the total paper organization was needed at the time, and would be necessary in the future, for three principal reasons.

First, the Board needed the prestige. Government agencies are hard to impress, and this appearance of a united front was effective. Furthermore, the Director of the Board needed entrée into offices and departments of Government so that the many established connections of the sponsoring organizations were invaluable. Both of the points apply equally well to the academic societies and institutions on which the Board theoretically depended for its information. The Councils are the known and trusted representatives of most of these organizations, and without their endorsement the Board would have been under suspicion.

Second, the Board needed financial support. The three Councils jointly are an effective combination in applying for support of an organization of this kind. Their unity is a convincing argument that the program is needed, that it will be well supervised, and that it is not competing with other projects. This would be equally true whether the sources of funds were Federal or non-Federal. In the case of the Ethnogeographic Board, the organizations most likely to compete had been incorporated, partly in this historical development, but also by the joint Council action.

Third, and most important, is the fact that no one knows in advance the direction that the activities of a Board of this kind will take. The Ethnogeographic Board was given a broad mandate, summed up under the term "service." The ramifications of service in this connection are almost unlimited. The review of the actual procedures shows that many of the sources of service were not utilized. However, part of the intention of this analysis is to show where sources could have been more widely and more effectively utilized, and in a future situation many unforeseen opportunities for service might well arise.

ORGANIZATION

The Ethnogeographic Board is a conglomerate organization, involving four sponsoring groups, Board members, a Directorate with a Washington office and staff, six cooperating committees, and a loosely assigned group of consultants. The historical account of the founding explains how some of these became united. The interrelationships, however, were not too clear at the beginning, and at the end of 3 years of operation this situation had not changed. The components are examined individually and then mixed.

Sponsors

"The Ethnogeographic Board is in effect a joint committee of the three research councils (National Research Council, American Council of Learned Societies, Social Science Research Council) with which the Smithsonian Institution cooperates to furnish a secretariat and office accommodations." (From the mimeographed statement submitted to the Foundations in the application for financial support.) Actually, the Smithsonian Institution was a full-fledged fourth Sponsor. The four sponsoring groups were represented on the Board by their Directors, jointly appointed the other members, and jointly applied for and received grants for the Board's support from the Rockefeller Foundation and the Carnegie Institution.

The Sponsors took an active interest in the Board, and controlled many of its policies, sometimes by concrete statements, sometimes by the negative technique of making no commitments. The prestige of the Sponsors was a great boon for the Ethnogeographic Board, but, also, so many masters had its drawbacks when quick decisions were required.

Board

The interdisciplinary character of the Ethnogeographic Board accounts for the sponsorship of three Councils instead of one, and also for the selection of the members. These were appointed jointly by the four Sponsors which was supposed to eliminate any idea of representation, although it is not difficult to guess which Sponsor proposed each member. In effect, however, the Board consisted of a group of independent scholars, and not of a body of representatives.

The Board met twice a year as an advisory and policy-making body. Beyond this it had no continuing function.

The original Board consisted of six members: Carl E. Guthe, anthropologist, University of Michigan, now Director of the New York State Museum, Chairman; Wendell C. Bennett, anthropologist, Yale University; Carter Goodrich, economist, Columbia University; John E. Graf, entomologist and Assistant Secretary of the Smithsonian Institution; Robert B. Hall, geographer, University of Michigan; and Wilbur A. Sawyer, medicine and public health, Rockefeller Foundation. Later the membership was increased to seven by the addition of Mortimer Graves, language and literature, American Council of Learned Societies. In the course of time, two members, Drs. Hall and Sawyer, resigned and were replaced by Isaiah Bowman, geographer, Johns Hopkins University; and William Duncan Strong, anthropologist and ex-Director of the Board, Columbia University. In general the Board had sufficient backing to allow selection of members for interest and action, rather than front or prestige.

The Board membership was kept small by deliberate policy. At one point the Board asked the Sponsors to add three more members, preferably in or near Washington, so as to give representation to such fields as history, political science, sociology and psychology. The Sponsors declined, on the grounds that the group was already working harmoniously and new additions might disturb this. In effect, this was true in that the members cooperated well and took a sincere interest in the work. That is, with the exception of the geographers, who, through lack of interest and because of other obligations, never appeared at a Board meeting.

Until 1945 the Board met twice a year, and the mimeographed minutes of the five meetings have been important documents for the present history. At each meeting, the Board reviewed the activities of its Directorate, discussed questions of policy, suggested new procedures, considered appointments to the staff, and approved the budget. The Sponsors thought of the Board as an advisory body to guide and aid the Directorate. However, no seven scholars are content to limit their discussions to advice, and consequently each meeting brought forth many suggestions on broad problems, techniques, and needs. Frequently these resulted in recommending new action for the Washington office, which harassed the poor Director, although seldom were such mandates clearly enough framed to guide his course of activity.

The Board appointed the professional staff members, consultants, research associates, and the like. It also set up a few subcommittees, such as the ill-fated ones on research and on the Pacific survey to be described later. At the request of the Director, the Board named an executive committee, composed of members permanently or frequently in Washington, who could be called on short notice for advice and approval. This committee, of four members, held some six official meetings at which minutes were kept, but served the Directorate with far greater frequency than this would imply. Insofar as the Board was intended to be merely an advisory group, all-Washington membership would have been desirable.

Directorate

The Ethnogeographic Board's Washington office, the only one it had, was located in the Smithsonian Institution. From two rooms at the start, four more were added as business increased. All these were supplied, serviced, and partly equipped by the Smithsonian Institution. The first Director, William Duncan Strong, served from June 15, 1942, to July 31, 1944, on leave of absence from Columbia University, and since his resignation, Henry B. Collins, Jr., of the Bureau of American Ethnology, Smithsonian Institution, has been Director. The salaries of both were paid by the Smithsonian.

The professional staff consisted of a Director and several "research associates," defined as full-time workers, with or without compensation from the Ethnogeographic Board. Without was more common than with, since only Miss Elizabeth Bacon received compensation from the Board's funds. The others, William N. Fenton, Frank H. H. Roberts, Jr., Homer Barnett, and Henry B. Collins, Jr. (later entitled Assistant Director), were all on loan from the Bureau of American Ethnology. The Smithsonian provided some secretarial assistance, in particular the service of Miss Mae W. Tucker, but the Washington office also had one or two full-time secretaries of its own. These include, for the period covered, Mrs. Ethel C. Ford, Miss Anne Fromme, Miss Elizabeth P. Clark, and Mrs. Mary Jane Miller.

All members of the professional staff assisted in the information service, and many of the reports show their collaboration. However, each research associate had a particular assignment. Dr. Collins was in charge of "research," by which was meant bibliography and other sources used in preparing reports and supplying information. Dr. Fenton was first in charge of the area roster, and later of the survey of area studies in American universities. Dr. Roberts was editor of the Board's survival reports, including the booklet "Survival on Land and Sea." Miss Bacon assembled the area (and language) notes, and participated in the survey of area programs in the universities. Dr. Barnett served as the executive secretary on the Pacific Survey Project, and later as director of the War Document Survey.

The staff worked together with remarkable harmony. Only in the case of the survey of area programs did the lack of positive directives cause some confusion. Four of the six staff members were regular employees of the Smithsonian, which, under the circumstances of being in the home building, might have led to divided loyalties. That this was not too disruptive is due in large part to the fact that the Directorate itself was practically a part of the Smithsonian, and certainly took over many of the functions of the Smithsonian War Committee.

The staff was competent, but too limited in number to handle many of the wider aims of the Board, particularly the establishment of sound academic relationships and the development of research promotion. At one point, the Director received permission to appoint a new man, who could relieve him of some of the routine, and at the same time undertake new projects. It proved impossible to find anyone, although many were considered, and some offers were made. This was only partially a question of salary, since the Ethnogeographic Board had reasonable funds. It can be attributed in part to the disagreement among the Sponsors on almost every man suggested, and in part because the job was necessarily of a temporary nature. Those seeking jobs preferred to go to one of the Government war agencies; those with jobs could not be persuaded to take a leave of absence for the purpose.

The question can be raised as to whether part-time personnel might not have been one solution. The Director claimed that the Board could not take on many large projects nor build up sufficient contacts with scholars because there was no staff member to assume such responsibilities. The attitude was that the man must be found first, and then the project or program built around him. If the approach had been reversed, and the project placed first, then it might have been possible to find the people to carry it out. This is merely conjecture, and might not have been possible during the drastic shortage of trained personnel in the war period.

Cooperating Committees

Five committees were associated with the Ethnogeographic Board even in its prenatal days: the Joint Committee on Latin American

Studies, the Committee on the Anthropology of Oceania, the Committee on African Anthropology, the Smithsonian War Committee, and the Intensive Language Program. A sixth, the Committee on Asiatic Geography, was formed as a result of a Board-sponsored conference. Its relationship to the Board was the same as the others, except that for fiscal reasons its finances were administered through the Board. In theory the Board was supposed to integrate the work of all these committees, although actually each remained an independent entity.

Consultants

Two categories of consultants were defined: "Consultants," who were representatives of committees and other organizations and who cooperated with the Board on a part-time basis; and "research consultants," who worked part-time for the Board without compensation. Both categories were appointed by the Board upon the recommendation of the Director. It was never clear whether the consultants were attached to the Board or to the Directorate. This was not very important because only a few were appointed. Raymond Kennedy, of Yale University, was the only one honored by the title of "research consultant." Five others were named as "consultants": George Peter Murdock, of the Oceania committee; Melville J. Herskovits, of the Africa committee; J. M. Cowan, of the Intensive Language Program; Douglas Whitaker, of the National Research Council; and Robert B. Hall, following his resignation as a Board member on account of war-service obligations.

The consultants were in no way organized in any formal fashion. At the one meeting held for the consultants only two attended. Probably closer affiliation and a greater number of consultants would have been helpful. At one meeting an extension of this type of relationship was proposed in the form of a committee of collaborators, but nothing was done about it.

Interrelationships

The Board and the Directorate were differentiated in fiction but not in reality. Theoretically, the Washington office represented but one activity of the Board, albeit that of major immediate importance. The Board could have set up other Directorates, or conducted a program independently of its Washington staff. But it never did, which makes the distinction between the two difficult to maintain. In actual practice, and in the eyes of all who used its services, the Washington office of the Directorate was "the Board." Throughout this report the term "Board" is used to refer to the advisory body, the Directorate, or to both combined. Where activities are described, the term usually means the Directorate; elsewhere, as in discussions of policy, it more often refers to total organization. As the emergency activities of the Directorate diminished the question of its relationship to the Board was sharpened. Should the closing of the Washington office automatically dissolve the Board? We now know that the Board expired when its right arm was amputated, but a skilled surgeon could theoretically have kept it alive.

In operation the Board and the Directorate were thoroughly interlocked. The Director attended every Board meeting, made his report of progress, and received advice and suggestions. The Chairman of the Board made frequent visits to Washington, and the executive committee also kept in close touch with the Director. The Washington office had liberal authority to initiate its own activities and was never merely an executive branch of the Board. In fact the minutes of the Board meetings when compared to the accompanying Director's reports sometimes show an amazing gulf between theory and practice. Had the Board ever shown any inclination to assert its independence by a show of action, the issue of relationship to the Directorate would have been raised. However, it never did.

The Board kept in touch with the cooperating committees by having the Director attend their committee meetings, by appointing the committee heads as consultants, by having the Directorate mimeograph and distribute the committees' personnel lists and reports. The Area Roster in the Washington office was the master file for all the committees' specialized personnel data. Only the Committee on Asiatic Geography expressed a slight resentment of the role of the Board as a central distributing agency. In general the cooperation with all committees was effective, although best with those on Oceania and Africa, not only because they were two basic creators of the Board, but also because they were composed of anthropologists, all of whom were old personal friends of the Director.

Representatives of the sponsoring institutions attended every Board meeting and the Director of the Board went to each annual meeting of the Sponsors. The National Research Council, the fiscal agent of the Board, received bimonthly reports, and all four Sponsors got the minutes of every meeting as well as special progress reports:

The Ethnogeographic Board, June 16 to October 16, 1942. A Report to the Sponsoring Institutions.

Director's Report of Progress, January 14 to August 1, 1943.

Brief Summary of the Activities of the Ethnogeographic Board, August 1, 1943, to July 31, 1944.

Report of Progress, Ethnogeographic Board, 1942-1945.

The Conference Board of Associated Research Councils discussed the Ethnogeographic Board at each meeting and sent copies of its minutes to the Director and the Board members.

General

The accomplishments of the Board, to be described in detail, reflect the organization. The Directorate determined the pattern and geared its staff for the various types of services to the Army, Navy, and war agencies. Judging by the quantity and quality of these services, the Board and the Directorate were successful. However, the total organization was inadequate for many needed research activities because the staff lacked the necessary personnel, the Director was too occupied by the immediate urgencies, and the Board itself was too remote and passive.

The Board was supposed to be interdisciplinary, but it is clear from this review of the organization that it was dominated by anthropologists. The Director and the five professionals on his staff, three out of the six consultants, the Chairman and one member (later two) of the Board, and four out of the seven official liaison officers with the Army and Navy were all anthropologists. The Board was created by the anthropological committees of the National Research Councils, and continued to be dominated by the one profession, in spite of attempts to branch out. This overemphasis may possibly have handicapped the full potential development of the Ethnogeographic Board.

BUDGET

The idea of an Ethnogeographic Board became a reality when the Smithsonian Institution offered to provide salaries for the Director and one assistant, office space and service, and some clerical assistance. The three Councils at once agreed to add a sum for other expenses during the initial trial period and to consider making an application for further financial support. The Ethnogeographic Board was launched, then, on a budget for the first 6 months of $3,000, plus the Smithsonian's contribution. Another $1,000 was added to this as a special item for the Committee on Asiatic Geography. The geographers spent about one-half of their fund, and the Board itself operated successfully on slightly less than its $3,000.

Before the close of this trial period the three Councils and the

Smithsonian made joint application to both the Rockefeller Foundation and the Carnegie Corporation for annual grants of $20,000 each. A budget of $55,000 to $60,000 for the calendar year 1943 was drawn up, partially on the basis of the first 6 months, but largely on forecasts of heavily increased demands. The Foundations would provide $40,000 of this and the Sponsors, principally the Smithsonian, would take care of the rest. Fortunately, the Foundations in making their grants did not insist on the calendar limit, but allowed any unexpended balances to carry over, since, at the end of the third year of operation, less than half of the $40,000 had been spent. This unusual situation requires an examination of the actual expenditures. Table 1 shows these by 6-month periods for the first 2 years.

The budgeted items for each 6 months refer only to Foundation grants and do not include the Smithsonian's contributions. Each estimated budget is about three times the actual expenditures for the same period, as is shown graphically in the chart (fig. 1). The estimates reflect the Ethnogeographic Board's enthusiastic notion of its own potentialities. The actual expenditures show both the Board's ability to get the jobs paid for elsewhere (namely, by the Smithsonian), and its inability to execute many projects. The totals for this 2-year period are:

Estimated budgets from grants	$47,364.94
Expended from grants	16,501.00
Smithsonian contributions	48,563.98
Total expenditures	65,064.98

It is obvious that the Smithsonian Institution has borne the lion's share of the cost. At the end of 3 years the Smithsonian's contribution had amounted to something over $60,000. This sum went largely for staff salaries, which, it must be noted, except for the Director's stipend would normally have appeared in the Smithsonian's budget. The estimate of $2,500 a year for office space and service is frankly a guess. The Board could not have rented equivalent space and service for this sum, but, on the other hand, the Smithsonian would have had to maintain it in any case. This is not intended to belittle the Smithsonian's contribution, which, on the contrary, made the work of the Board possible at remarkably low budgetary cost. If the Foundations consider matching funds desirable, they certainly received it in this case. In 3 years the Sponsors matched the grants at a ratio of three to one.

The grossly overestimated budgets reflect in part the Directorate's concentration on low-cost war service in contrast to the Board's wish-

TABLE 1.—*Ethnogeographic Board: Budgets, expenditures, and Smithsonian contributions by 6-month periods for the first 2 years*

	1942B Budget	1942B Spent	1943A Budget	1943A Spent	1943B Budget	1943B Spent	1944A Budget	1944A Spent
A. Board	$685.00	$499.52	$3,000.00	$871.35	$900.00	$432.40	$900.00	$297.35
B. Directorate:								
1. Salaries	1,065.00	980.00	4,080.00	1,772.97	5,580.00	2,026.30	8,880.00	3,734.82
2. General	450.00	245.85	4,000.00	458.71	600.00	......	300.00	......
3. Office	425.00	415.47	1,200.00	559.18	600.00	424.56	600.00	514.59
4. Equipment	375.00	255.31	800.00	351.69	500.00	145.00	500.00	244.85
5. Asiatic Geog.	1,000.00	451.98	708.90	240.88	468.02	......	468.02	23.20
6. Pacific Survey	......	......	......	......	1,200.00	......	1,200.00	51.03
7. Area Study Survey	......	......	......	......	1,200.00	84.57	1,500.00	924.42
8. Contingent	......	......	1,920.00	545.00	1,120.00	......	1,120.00	......
Totals	4,000.00	2,798.13	15,708.90	4,799.78	12,168.02	3,112.83	15,468.02	5,790.26
C. Smithsonian:								
1. Salaries	......	9,300.00	......	10,750.00	......	10,250.00	......	12,050.00
2. Rent	......	1,250.00	......	1,250.00	......	1,250.00	......	1,250.00
3. Construction	......	1,213.98	......	......	......	......	......	......
Totals		11,763.98		12,000.00		11,500.000		13,300.00
Grand Totals		14,562.11		16,799.78		14,612.83		19,090.26

ful hopes for more "research" projects and planning. In the application to the Foundations, for example, the $55,000 annual budget estimated six Board meetings a year, although no more than two a year were ever held, nor would they have been practical. An item for five consultants a month at $100 each was not explained in the application nor ever clarified in practice. Six to ten projects at $500 were itemized by a Board which later restricted grants by policy and seldom considered the employment of part-time personnel. On the basis of 5 successful dinner conferences in 1942, the Directorate estimated 20 in 1943 at a total cost of $5,000 ($75 per conference dinner, plus $3,500 for traveling expenses), but owing to war restrictions only 5 more were held.

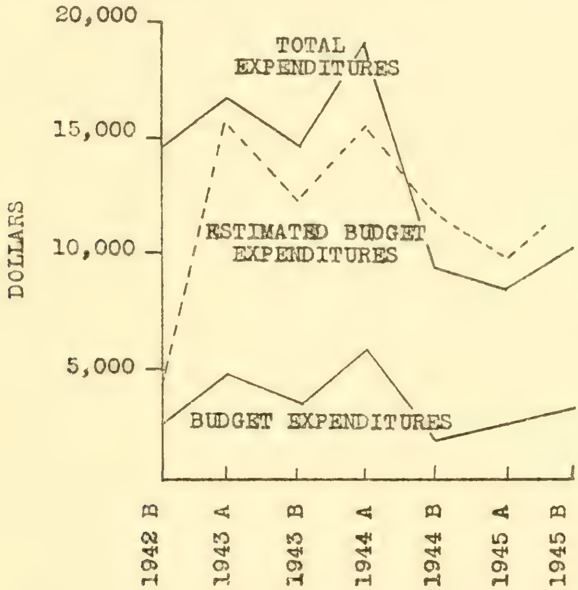

FIG. 1.—Graph of Ethnogeographic Board's budget.

In estimating its budgets the Director made allowances for hiring additional staff members. However, this was not necessary for many projects because the Smithsonian loaned members of its staff, which increased its contribution but did not deplete the Board's operational budget. For illustration, the Pacific Survey Project cost the budget only $51.03. If outside personnel had been hired the Board's expenses would have increased proportionately. The concentration on war service rather than research promotion cut down the costs enormously, since it took little expenditure to answer questions, distribute materials, and write brief reports. For future consideration, however, it must be remembered that the total costs amounted to about $30,000 a year which would have to be met by grants if no convenient Smithsonian Institution were available and willing.

BOARD ACTIVITIES

The chapters which follow present a description and analysis of the actual activities of the Ethnogeographic Board. No attempt has been made to arrange these in chronological order, a procedure which would be exceedingly difficult and of little general significance. Instead the treatment is a topical one, with an emphasis on techniques and the different types of service.

Service is a multifarious concept, but for the purpose of this description it has been limited to those aspects which actually are demonstrated by the Board's endeavors. Convenient labels have been attached, such as Information, Distributions, Reports, Conferences, and Projects. Each of these covers a rather wide range of activities, as will be illustrated. The caption "Dead Ends" covers the projects and techniques which the Board discussed or initiated, and then abandoned for one reason or another.

It must always be remembered that the Ethnogeographic Board was primarily an emergency body intent on using academic knowledge for the successful execution of the war. There was, to be sure, a secondary purpose, as stated in the published brochure, "to encourage the promulgation . . . of more extensive research projects along the lines of applicable social science, linguistics and human geography." It was the primary purpose, however, that motivated the Director and his staff, and that colored the activities of the Board throughout the first 2 years of its existence. Requests from the Army, Navy, and other war agencies were given precedence above all others. Longer term and more academic projects were consistently postponed in favor of the immediate. It is natural then that the category "Information" stands out most prominently in this history.

Information includes the spot questions about areas or personnel which could be answered by phone or short letter. It includes short reports in answer to requests that required a certain amount of investigation. It includes long reports involving one or more staff members, or the most competent outsiders available. The promotion techniques of the Washington office were intended to spread the scope of this service. The principal files, such as the Area Roster, area bibliographies, and the specialized library, were assembled and arranged in order to facilitate and improve the information sources.

As the Government agencies became more stabilized, war areas contracted, and foreign intelligence replaced the domestic, the demands on the Board's information service dwindled. The first year of operation was the period of greatest activity. By the end of 1943 requests were notably fewer in number and correspondingly of greater complexity. After 2 years the first Director felt that the Ethnogeographic Board's primary objective had been achieved, and tendered his resignation since, as he stated in a letter of June 21, 1944, " . . . I came to Washington primarily to be of service in the war effort. . . ." He felt that the nature of the activities would, and should, change. His prediction was correct, since the third year was marked by requests for other than pure information.

The Board received its initial direction from those cooperating committees which it, in part, represented. Once connections with War and Navy Departments were established, the nature of their requests controlled the efforts of the staff. At the semiannual Board meetings, the members offered guidance to the Directorate and suggested new action. Since these suggestions were frequently not of a strictly informational nature they were seldom practical for the small, overoccupied Washington staff. The Board members emphasized the dual function, to answer and to sell. The Director gave priority to answering. His office was perfectly willing to distribute and promote any pertinent materials, but did not have time, staff, nor techniques to stimulate the scholarly profession in the production of more salable documents.

The description and analysis starts with the Area Roster, the Information Files, and the Promotion Techniques. Unfortunately, the various activities of the Board cannot be neatly segregated. The roster was compiled largely during the first year, but the information service started the first day. A letter answering a query would often include data on personnel, photographs, bibliography, and a promotion pamphlet, so that any description which separates these activities must not only be somewhat artificial, but also involve some duplication. In some ways this topical approach may seem to oversimplify, but little clarity would be gained by a presentation of the Board's first year's rush of business.

AREA ROSTER

The Board built up a file of the area experiences and linguistic abilities of some 5,000 individuals which it entitled: "World File of

Area and Language Specialists." This roster, unique in many ways, was constantly used both by the Washington staff and by other agencies. The emergency value of the roster and its potential future importance justify a detailed description.

Need

Rosters are no novelty. The American public seems to enjoy writing its name and experience on a questionnaire blank, and many an organization finds pleasure in assembling this information in files. Who's Who, American Men of Science, and other publications cover the field of up-to-date biographical references. Most professional societies keep records of the careers of members. All these lists allow some evaluation of the individuals. In wartime Washington, with personnel at a premium, almost every agency drew up its own list of experts or potential employees. These were classed as house documents, not for circulation. Others, like the Office of Strategic Services list of Near Eastern Authorities, bore the label: "Not for distribution to non-Governmental agencies."

Of all the rosters which the Board examined before starting its own, the most important was the National Roster of Scientific and Specialized Personnel (NRSSP). This is undoubtedly the most complete and significant registration of the country's scholarly personnel. Started well before the war, the National Roster makes every effort to record up-to-date information on all scientific fields. During the war it became an important part of the War Manpower Commission.

Before the Ethnogeographic Board was established, each of the area committees felt the need for specialized area rosters. The extant printed biographies and even the National Roster were not satisfactory from the area point of view. The personnel lists assembled by these committees formed the core of the Board's Area Roster and stimulated its expansion to cover the other areas and utilize other sources. A large volume of the Board's information service concerned personnel data, so that it was inevitable that a handy reference file would be needed.

Apart from the practical convenience of an office personnel file, there was a recognized need for a roster which placed the primary emphasis on area. The Board wanted to know who had been where, how long, doing what. The experience of the Oceania committee had shown that if such a list were limited to professionals it would be pitifully small. Furthermore, it was reasonable to assume that significant knowledge and materials on an area could be acquired by nonprofessionals, particularly those with extended residence. The roster was built up to meet this area requirement.

There was little question of duplication or conflict between the Ethnogeographic Board and its cooperating committees, since, in effect, the Board's roster served as the master file. There was, however, the question of competition with the National Roster. This was carefully considered and amicably discussed by the two organizations. The National Roster was limited to professional scholars of the United States, arranged primarily by discipline and profession, and not evaluated. It placed area and language familiarity in a secondary category. The Board's roster included professionals and nonprofessionals, citizens and foreigners. It emphasized area knowledge, length of residence, and linguistic ability. Instead of competing, the two rosters would complement each other. Actually the staff used the National Roster as a major source for its preliminary lists, which were then checked and sorted according to the area requirements. On the practical side the Board's information service required speed. The National Roster was so overburdened by requests at the beginning of the war that it could not have assumed responsibility for another major job.

The centralization of area personnel information at the Board received military sanction. The Intelligence Branch was worried about the miscellaneous distribution of special personnel lists and formally requested that the distribution of lists, and the master file, be controlled by the Board.

The laborious and painstaking task of building up the Area Roster was assigned to William N. Fenton, research associate. For the first year, as he discovered, this was no part-time job for one man and a secretary. The Smithsonian as usual lent its assistance in the form of clerical help and the services of its archivist, Miss Mae W. Tucker.

Sources

The cooperating committees furnished the basic personnel lists for the Area Roster. The Committee on Latin American Anthropology furnished an evaluated list of United States anthropologists with Latin American experience. The Committee on Asiatic Geography furnished a list of some professionals. The best evaluated language experts came from the Intensive Language Program's file. The Smithsonian War Committee provided information on the area experience of the Smithsonian staff. This was very useful because the individuals were available at all times. The lists from the committees on the Anthropology of Africa and Oceania formed the backbone of the roster since they had been built up on strictly area lines. Although the Board kept all these lists and had many of the original questionnaires, only the most promising names were included in the active card file. In some instances a new questionnaire form was sent to the individuals in order to fill out gaps in the information.

The Area Roster was built up for service rather than for complete coverage of the world. Consequently, names were sought for those areas of greatest immediate or anticipated importance. The first ones were the Mediterranean, Africa, and the Pacific Islands. The Board appealed to professional societies and institutions, such as the American Political Science Association, the Rockefeller Foundation, and the Library of Congress, whose members might have special knowledge of these regions. Others, like members of the American Association of Petroleum Geologists, and the American Malacologists Union, could be expected to have special knowledge of terrain and beaches. The offices of both Army and Navy Intelligence gave their assistance. Government agencies with foreign service divisions were not overlooked. The Department of Agriculture and the Board of Economic Warfare agreed to send the roster questionnaire to their experienced employees. The Archaeological Institute of America, the International Labour Office, the Explorers Club, and the International Committee of the Y. M. C. A. furnished names of nonprofessionals with area knowledge. Names of missionaries were obtained from the American Friends Service Committee, the Baptist Foreign Mission, the International Missionary Council, and others. The National Roster of Scientific and Specialized Personnel supplied basic lists of specialists with foreign travel or residence.

The Board members and the Sponsors suggested new sources and even persuaded some societies to send their lists to the roster. Such lists were filed for future reference if not pertinent to the immediate need. For example, the Board had access to the Intensive Language Program's list of language teachers and trainees. Similarly, the American Friends Service Committee deposited a complete set of curricula vitae of specialists on Central Europe who were teaching in the Language-Area programs at the universities. If the Board wanted to include names from these lists in its master file, the society itself was asked to send out the questionnaire, a technique which usually gained a wide response. However, only selected individuals with special knowledge of a strategic area or special linguistic ability were entered in the card file.

Some requests called for special efforts. In response to special requests, the Board obtained a list of Scandinavians in this country from the American Scandinavian Foundation; a list of citizens who returned from the Orient on the Gripsholm from the War Department and the Board of Economic Warfare; and a list of Russian residents from the Russian Students Relief Fund, Inc. Finally, the chain letter system was employed. Each questionnaire or circular which the Board sent to an individual asked for the names of others who might have useful knowledge or experience.

The sources of names were not formally rated, although in terms of a particular project some proved far more valuable than others. In general, the number of sources or card entries was purely pragmatic. If the information from one set proved inadequate, new ones were sought.

Principal Sources

1. American Association of Petroleum Geologists.
2. American Council of Learned Societies.
3. American Friends Service Committee.
4. American Malacologists Union.
5. American Men of Science.
6. American Oriental Society.
7. American Political Science Association.
8. American Scandinavian Foundation.
9. Archaeological Institute of America.
10. Baptist Foreign Mission.
11. Board of Economic Warfare.
12. Chicago Technical Societies, Association Defense Committee.
13. College Art Association.
14. Committee on African Anthropology.
15. Committee on the Anthropology of Oceania.
16. Committee on Asiatic Geography.
17. Committee on Latin American Anthropology.
18. Committee for the Protection of Cultural Treasures in War Areas.
19. Directory of American Scholars.
20. East Indies Institute of America.
21. Explorers Club.
22. Federal Council of Churches of Christ in America.
23. Foreign Missions Conference of North America Committee.
24. Foreign Press Club.
25. Intensive Language Program.
26. International Committee, Y. M. C. A.
27. International Labour Office.
28. International Missionary Council.
29. Library of Congress.
30. Military Government, Provost Marshal General's Office.
31. Military Intelligence Service, U. S. Army.

32. National Roster of Scientific and Specialized Personnel.
33. Office of Navy Intelligence.
34. Rockefeller Foundation.
35. Russian Students Relief Fund, Inc.
36. Smithsonian War Committee.
37. United States Department of Agriculture.
38. United States Department of Commerce.
39. Who's Who in America.
40. Who's Who in Engineering.

Files

The questionnaire blank used by the Ethnogeographic Board was intentionally modeled on the ones devised by the Oceania and Africa Committees. The form, to be sure, was generalized so as to be suitable for any world area, and it was also greatly simplified. (See Appendix B4 for an example.)

The questionnaire stresses the geographic region, the major area, subarea, and specific locality, with which the individual is familiar. He is asked to state the length of his residence in the area by years and months, and to indicate the number of photographs, motion pictures, maps, and other materials which he possesses for each region. The correspondent rates his facility in native or European languages. The occupation, address, phone, place and year of birth are standard questions, as well as professional experience and academic degrees. Finally, the individual is asked to add the "names and addresses of other important travelers." This simple, one-page blank, is accompanied by a sheet of instructions which explains the particular items.

The information on a selected number of individuals was transferred to a printed 5×8-inch card, a sample of which is shown in figure 2. All pertinent data were entered on one side of the card, and the reverse side recorded how, when, and to whom the data were supplied. If an individual was familiar with several areas, a separate card was made out for each. At first, the total information was entered only on the first card, and the others were cross-referenced. This proved so unsatisfactory that subsequent cards were filled in completely.

Each card had a key reference to the source which furnished the individual's name, so that an evaluation could be obtained if necessary. The original questionnaire blanks were filed in alphabetical order, together with a folder which contained pertinent correspondence, some additional information, and any supplementary reports which the individual may have sent in either voluntarily or by circularized request.

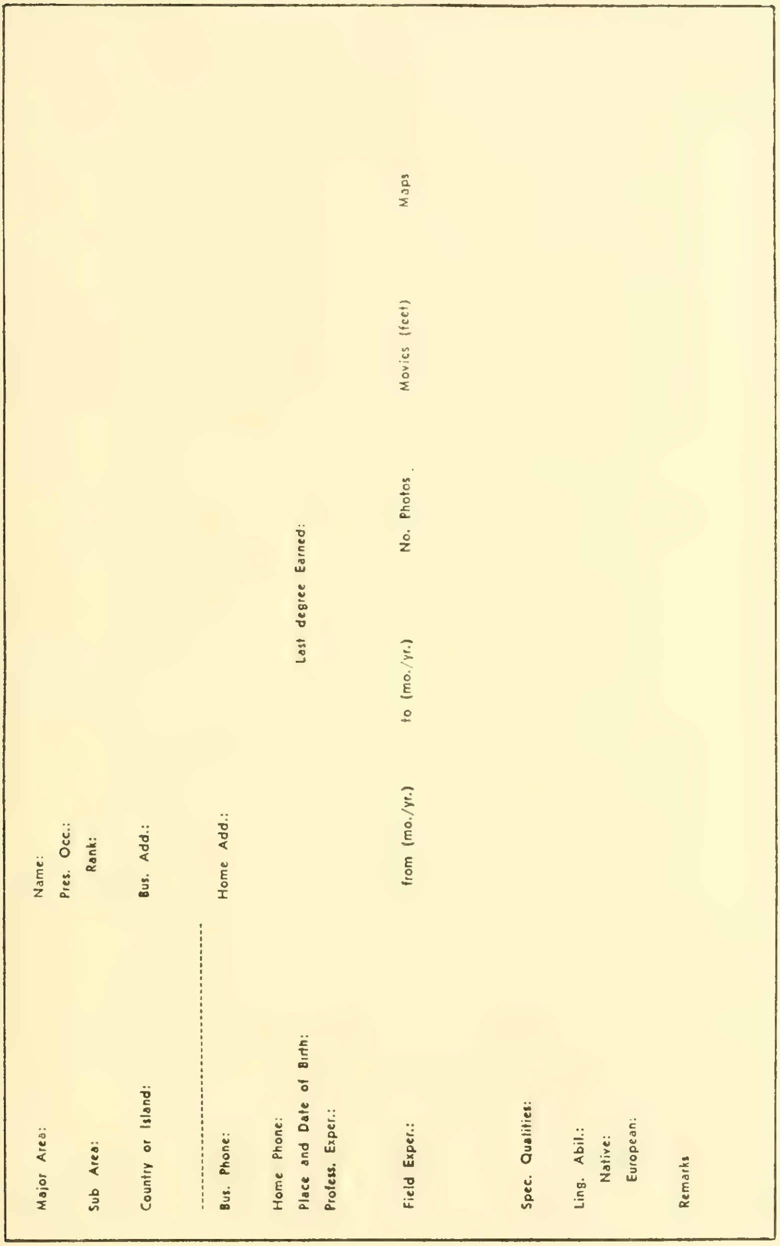
Major Area: Name:
Pres. Occ.:
Sub Area: Rank:
Country or Island: Bus. Add.:
Bus. Phone: Home Add.:
Home Phone:
Place and Date of Birth: Last degree Earned:
Profess. Exper.:
Field Exper.: from (mo./yr.) to (mo./yr.) No. Photos Movies (feet) Maps
Spec. Qualities:
Ling. Abil.:
Native:
European:
Remarks

FIG. 2.—Sample of Area Roster filing card. Actual size, 5 × 8 inches.

The information cards were filed by major area (Africa) and subdivision (Abyssinia). A separate alphabetical file of name cards contained no personal information, but noted all areas under which cards for that individual could be found. There was no cross-index by disciplines or linguistic abilities. To find the names of anthropologists who had worked in Africa required a half day's search; but then, this was not the purpose of the roster.

All rosters soon get out of date. The Board was mainly interested in the immediate utilization of its roster and consequently made only casual efforts to keep it current. If new information came in, it was duly recorded, but there was no systematic attempt to obtain it. The Army and Navy would have liked information on the draft status of the individuals, although in many cases such data were available through the National Roster's system of having each of its registrants mail in a card when classified as immediately draftable. At one point the Army proposed that the Board build up a selected roster of regional and language specialists and cooperate with Selective Service in getting them usefully placed in the armed forces. This request produced intense activity among the Staff but, fortunately for the peace of the Board, the Army completely forgot about this plan 3 weeks after it had first suggested it. At the time, however, the Board considered the problem as one of major importance; it is one which has not yet been solved.

The major efforts in building up the Area Roster continued for something over a year, since which time it has received only occasional attention. The December 1943 approximation of the size and coverage of the roster is adequate for illustrative purposes. Over 5,000 individual names were included with an area coverage, including duplications, as follows:

	Cards
Africa	2,450
Asia	1,300
(e.g., Japan, 200)	
(e.g., Burma, 75)	
Europe	2,550
(e.g., Germany proper, 200)	
Latin America	1,600
North America	300
Oceania	2,450
(e.g., Sumatra, 175)	
(e.g., Philippines, 500)	
Total	10,650

Evaluation of Individuals

Every compiler of a roster ultimately faces the problem of evaluating the individuals on his list. For example, when a man writes in "fluent" to describe his ability in speaking Malayan, what are the chances that he has more than a halting, 10-word vocabulary? This may seem far-fetched, but experience has shown otherwise, particularly when the rating is done by the individuals themselves.

Evaluation, except for such sweeping generalizations as "good" or "terrible," must be done in the framework of a particular request, job, or project. Attempts to evaluate in terms of hypothetical frameworks are time-consuming and of dubious value. For example, the Committee on Latin American Anthropology set up a jury of eight to rate the linguistic and professional qualifications of each anthropologist on its list, but even this simple technique broke down when the Joint Committee on Latin American Studies tried to apply it to historians, sociologists, language teachers, and others. These fields were so large that no jury could possibly be personally acquainted with any significant number of the individuals.

The Ethnogeographic Board made an over-all rating by inspection and selection. Each questionnaire was examined to see if the individual's experience and materials might be of service. If so, the entry was made on the filing card. Other evaluation techniques were utilized only when a particular request made them necessary.

The Board was frequently asked to recommend someone for a particular job or to furnish the names of individuals with specific area knowledge. In these cases the Board's obligation was defined by a memorandum from Military Intelligence Service: "In all cases, the qualifications of such scientific personnel will have been evaluated by the Ethnogeographic Board, and their loyalty and reliability been investigated by the Counterintelligence Branch, War Department, or equivalent agencies." For these evaluations, the Board used the standard biographical reference books, sought the opinions of others in the man's professions, and checked with the source which had furnished the man's name. Some evaluations were made by the cooperating committee which specialized on the area in question.

Many individuals in the Area Roster were sent requests for maps, photographs, and specific information on a particular area. Rough evaluations were used in selecting the individuals who would receive these requests. For example, the Oceania Committee had followed up its original questionnaire with a second one calling for details of resources, topography, and population of certain islands. A generalized judgment of the individual's real knowledge could be obtained from these answers. Likewise, a rough rule-of-thumb evaluation was based on the length of residence in an area, the particular interests, etc.

Most questions of linguistic abilities were turned over to the American Council of Learned Societies which was better equipped to make a judgment or administer a test. In some cases, however, the Directorate handled such requests. For example, a request came for a list of Russian-speaking personnel in this country who had professional training equivalent to the Ph.D., especially in engineering, medicine, dentistry, physics, and other technical sciences. The roster contained few such names, and sources like Who's Who in Engineering had equally few. The Board turned to the National Roster and got a list of scientists, many of Russian birth, who claimed to be familiar with the language. The Russian Medical Society, the Russian Student Fund, Inc., and Dr. Paul S. Galtsoff furnished other names. All these lists were turned over to a competent Russian scholar who rated each individual's claims on the basis of his education in Russia, the duration of his residence and his general background. Out of 251 names from the National Roster, 139 were accepted as competent.

For some requests, however, the Board used a shotgun technique in preference to time-consuming methods of evaluation. Five hundred or more selected names from the roster would be circularized, and if the salvo brought down a brace of fat ducks everyone was happy. It usually worked.

Uses

The Area Roster received extensive use. It was consulted at some point by every war agency and by most of the prominent civilian agencies. At first the agencies concerned with military matters had the greatest interest in personnel information, but later the roster was consulted frequently by those interested in rehabilitation, relocation, and postwar planning. The Board encouraged direct consultation of its roster by distributing a mimeographed description of its nature and content to many Government agencies. To all who came, the staff offered personal assistance in order to obtain the most effective results.

The staff made constant use of the roster as part of its information service. A letter which furnished area information would also list the names of individuals who knew the region and consequently might be able to supply additional material. In this sense the use of the roster definitely overlaps the information service category of this history.

I. LISTS OF SPECIALIZED PERSONNEL

The staff drew up lists of specialized area personnel both on request from an agency and in anticipation of needs. Some of these had a confidential, restricted distribution; others, considered to be of wide interest, were mimeographed. In a very real sense these lists served the purpose of a cross-index to the roster. Examples of such prepared lists are:

Confidential personnel list of Thailand.
Confidential personnel list of French Indo-China.
Confidential personnel list of Malaya.
List of Russian-speaking authorities.
Partial list of Oceania experts in Washington.

Some of the lists contained rather detailed information, others were simple, depending on the purpose. The list of Oceania experts in Washington includes name, office address and phone number in Washington, profession, and the specific islands known. This was sent around with a note asking for additions and corrections, and many were submitted. Following this, the Board built up a more extensive file of scientists and regional specialists in or near Washington, which included over 1,000 names and was constantly revised. This file enabled the Board to bring questioner and expert together without delay.

Most requests were for the names of individuals who had lived or traveled in some area. Some were turned over to the cooperating committees for answers. For example, the Africa committee handled an Office of Strategic Services request for a short list of businessmen, government employees, and native leaders, resident in Liberia; and an Army request for individuals with experience in Africa who had served in any branch of the Armed Forces previous to 1935.

A reply to a simple request, such as a list of people who had lived or traveled in Gambia, included the name, address, business or profession, and months and years residence in the area. Sometimes the names of those who appeared to be most suitable in terms of the request were starred. Some requests were very specific. One called for an evaluated list of personnel having an intimate knowledge of coastal conditions in (1) Louisiade Archipelago; (2) South Papuan Coast, particularly east of 146° east longitude; (3) Bismarck Archipelago. At least one conchologist was wanted who knew each of the areas. The list was sent, shell specialists and all, within 6 days. Some requests specified disciplines, for example, social anthropologists with field experience in social analysis. Others desired names of individuals who might have specific materials, such as large-scale maps of Greece. When this last request was answered, the accompanying letter pointed out that most of the individuals were archeologists and consequently it might be advisable to inquire about Balkan maps in general at the same time.

2. SOURCES OF PHOTOGRAPHS

More elaborate compilations utilized the detailed information contained in the roster. These are illustrated by the "Sources of Photographs" lists. The roster questionnaire included data on numbers of photographs, feet of motion picture film, maps, and other materials such as diaries, unpublished manuscripts, etc. Dr. Fenton compiled this information in terms of the areas which would most likely be of greatest interest to the Army and Navy, after considered consultation with the respective liaison officers. One compilation consisted of four parts and an index, entitled as follows:

I. Sources of photographs on Netherlands East Indies; not already requested by the Navy Department; together with a map showing their distribution.
II. Sources of photographs on Southeastern Asia (Burma, Thailand, Indo-China and Malaya).
III. Sources of photographs on Japan (Chosen, Japan, and Formosa).
IV. Sources of photographs on the Philippine Islands.

Index to sources of photographs of I-IV above.

These four sections and index made up a manuscript of 188 pages. After each individual name was the standard information on nationality, address, profession, years and months of residence in the area, and also the quantity of pictures, maps, and miscellaneous information which he claimed to possess. If any war agency had already requested the materials, this fact was noted together with the name of the agency. Those whom the Ethnogeographic Board had already circularized for the Navy were not included, as the document titles state.

The sources of photographs for each particular region were indicated by numbers on a large-scale map. In the index the names in the four reports were numbered consecutively so that a reference to the specific sources of photographs could also be indicated on the maps. The job of actually obtaining the photographs and other materials was left in the hands of the Army and Navy.

3. PERSONNEL INFORMATION

The Board's roster served as one source for employable personnel, particularly when cross-checked by one of the cooperating committees or Sponsors. Samples of such requests are: a man to write the Soldier's Handbook on Eritrea; a man to check a military phrase book in "Pidgin English"; a good cultural-relations officer for the Caribbean area. The Board was able to furnish the names of several individuals who spoke a specific Oceanic dialect, in spite of the fact that other informed sources had claimed that no such people were available. The Army, Navy, and other Government agencies used the roster to obtain names of prospective officers or employees with foreign experience. Some use was also made of the roster by universities seeking special teaching personnel for their foreign area and language courses.

4. FOLLOW-UP INTERVIEWS

At several Board meetings the possibility of interviewing people with extensive area travel or residence was discussed, but never tried out. However, this was done by some agencies such as the Office of War Information, the Army and the Navy. It is costly and difficult to interview a group of people scattered all over the United States. In order to simplify the procedure, the Navy, in 1944, asked for a special list of area experts arranged according to United States subregions represented by Naval District Offices. The Board selected 550 important card entries, made two photostats of each, and classified these by States and institutions. One set of photostats was for the Navy's central file, the other for the District Officers'.

5. CIRCULARIZING

At first the military departments handled all follow-up requests for photographs and information, but later the Board was entrusted with a good proportion of this work. The Army or the Navy designated the specific area, such as the Balkans, Japan, or a Pacific Island group, and the type of information desired. The Board then selected a long list of potential names from its roster and sent the request to each individual. An accompanying letter gave details about the type of information, photographs, and maps which were needed. (See Appendix C for samples.) If Army and Navy requests differed, this was explained. In order to avoid duplication the letter asked for the name of any other war agency which had solicited the same information on materials. In some earlier individual requests, the correspondents had been asked to send their information directly to the Board, which would turn it over to the Army or Navy. This had sometimes aroused suspicion. Consequently, the later requests enclosed Navy or Army franks so that the materials could be sent directly. By this means it was unnecessary to give any elaborate explanation about the Ethnogeographic Board, although the printed brochure was enclosed for good measure. If the roster did not contain enough names, other sources were used. For example, good materials on the Mediterranean were obtained by circularizing the membership list of the Archaeological Institute of America and of the American School at Athens.

A recent illustration shows the results of this circularizing technique because it was handled entirely by the Board. The American Commission for the Protection and Salvage of Artistic and Historic Monuments in War Areas wanted Baedeker's Guides to Germany and Austria for its special Army officers. As the Commission had already canvassed the large art galleries and museums and the second-hand book dealers, supplies of Guides were exhausted and the Board was asked to assist. A mimeographed letter which explained the need and requested the sale or donation of such Guides, was sent out at the end of April 1945 (See Appendix C4). The statistics on June 15, 1945, were as follows:

Total requests mailed	473
Requests not answered to date	288
Negative answers with no new names suggested	92
Negative answers, but with new names suggested	58
Affirmative answers	35
Baedeker's Guides received	63

The Guides received in response to this request proved sufficient for the needs of the American Commission and circularization was stopped. The Director, however, offered to send out a new batch of letters if the situation changed. Many of the Guides were received from members of the Archaeological Institute of America of which William B. Dinsmoor, a member of the American Commission, is president.

Appraisal

It was inevitable that the Ethnogeographic Board with its emphasis on world areas would build up a roster of area specialists. From the point of view of technique of procedure the job was well done. The emphasis on area and language, the simplicity of the questionnaire and the filing system, the concept of usefulness rather than completeness, were all consistent with the primary purpose of the Board. The roster was available to all agencies, both requests and consultants received personal attention, and the service was rapid and accurate—all important factors in wartime Washington.

The service was good, but a fair estimate of its effectiveness is impossible. What use was made of the many lists which the staff prepared, either on its own initiative or on request? Presumably the Navy, Army, or some other agency wrote to the individuals or interviewed them, but the quantity or quality of this follow-up is not available in the Board's records, and probably never will be. The letters of acknowledgment are polite enough. For example, the Sources of Photographs Reports I-IV were acknowledged as follows by a Rear Admiral: "The Navy Department is very appreciative of the time, work, and effort of the Ethnogeographic Board in preparing these valuable lists, compiled from your World File of Regional Specialists, and especially wishes to compliment you and Dr. Fenton for the excellent way the studies have been prepared." This shows genuine appreciation of the service, but gives no basis for evaluating the results. There is some indirect evidence that useful photographs were obtained, but it is not a matter of public record owing to the confidential nature of the material.

It is unfortunate, although understandable during the war, that the Ethnogeographic Board was not allowed to assist in the interviewing. The representatives delegated to examine the Area Roster were not always of the highest caliber, and it is probable that the interviewing was not always in the hands of those skilled in this technique. The Board might have been able to make a real contribution by selecting the interviewers. Few area specialists would be able to answer the questions about beaches as framed by the Army instructions: "Degree of slope, both above and below high tide level; nature of adjacent terrain . . . ; currents, tides and surf—seasonal variation; offshore obstructions. . . ." However, some of this information might well have been obtained by a trained interviewer who talked about sailing, fishing, swimming, and picnics.

Even in those cases where the Board sent out circular requests it is difficult to judge the results because the materials were sent directly to the Army and Navy. However, some of the replies are in the office files from which it can be ascertained that the quantity response was good, but that quality was often sketchy. Many of the individuals had already been approached by the Office of Strategic Services or some other war agency. From the small amount of material that the Board received directly, and from the liaison officers' reports, it is certain that at least some important results were obtained. Furthermore, both the Army and Navy continued to request this service, which would not have happened if the results were all negative. If the request for the Baedeker's Guides is at all typical, the effective response could be estimated as between 7 and 8 percent. which is certainly creditable. In many cases the approach was somewhat hit or miss, but the over-all impression is that the hits were frequent enough to justify the procedure.

Although the Area Roster continued to be of some service until the closing of the Board, its future value is dubious. An ex-traveler or resident is seldom as good a source of information as the man on the spot, and unoccupied spots have diminished rapidly. The Board did not undertake the recording of all the new experience and training, so its files are largely outmoded. The 5,000 names now in the card file could probably be reduced to about one-tenth of that number, whose experience would be of postwar value. If this were done, the task of building an up-to-date file would be simplified. The Board's roster technique could be followed in a future emergency with about the same success. There will always be sources of names for questionnaires and follow-up requests or interviews. Perhaps, however, a more systematic registration of area experience and trained personnel will be devised in the interim.

Obvious lacunae in area knowledge and personnel influenced the building of the roster, but the files themselves do not permit any sound evaluation of the true situation. The greatest efforts were made to fill in the little-known regions. Areas outside the war theaters were intentionally neglected, and little attention was paid to the better-known countries of Europe. In other words, the roster does not serve as a yardstick for the specialized personnel of world areas. Some have considered the inclusion of so many nonprofessionals a deplorable situation, but it is equally valid to use this as an indication of the value of registering the experience and organizing the knowledge of "amateurs."

INFORMATION FILES

With the exception of the Area Roster and the Cross-Cultural Survey file, the Washington office had few systematic information files. The advisability of creating a backlog of information and sources in anticipation of needs was discussed at one of the first Board meetings, but relatively little was ever done about it. Instead, the Directorate depended on its own knowledge of sources and on the resourcefulness of its Sponsors. This was a deliberate policy.

The Director's diary records an interview with a Navy representative who came in to ask about motion picture films for area instruction. The Director agreed to locate and evaluate practically anything that was wanted but added that he was not interested in making more lists such as everybody else was doing.

Bibliography

As an important part of its information service the Board supplied the agencies with bibliographical references, and often the books themselves, either upon direct request or as supplementary material to a report. Henry B. Collins, Jr., present Director of the Board, and formerly Assistant Director, was in charge of all "research" activities, including the bibliographical. A basic area bibliography resulted from his personal survey of the resources of the Library of Congress, the Smithsonian Library, and the Library of the Department of Agriculture. Like the roster, the bibliography was directed toward immediate needs rather than completeness. Additional references were sought in terms of specific requests. Since the bibliography followed the area pattern, geographic references were most frequent. Each item was evaluated in terms of maps, illustrations, and type content.

The bibliography was not arranged in any formal card catalog. Some of the references of general interest were included in a mimeographed report entitled "Area (and Language) Notes" and distributed to the universities with area study programs. It is possible that more of the bibliography might be worth organizing for a permanent record.

Reference Library

The Washington office was in the building that houses the splendid Smithsonian Library, so the Board did not have to accumulate many books of its own. Standard biographical references, and books of a general nature on important regions, particularly ones with good bibliographies, were purchased, and some Government documents, both published and mimeographed, were acquired. All these books were acquired for their usefulness and convenience, but there was no intent of building up a specialized library.

Survival Library

From its inception, the Board took a special interest in survival literature. The staff's ethnologists were particularly irked by reports of stranded aviators practically starving in tropical jungles which had plenty of edible resources if knowledge of their recognition and preparation were available. The Board stimulated the preparation of many reports on how to survive which received wide circulation in Army and Navy service publications. The Board also built up a special library and bibliography on the subject of survival. It acquired many manuals published by the Army and Navy, such as the War Department's Basic Field Manuals, and the Bulletins of the Arctic, Desert, and Tropic Information Center, as well as those published outside of the Government, such as "South Sea Lore," by the Bishop Museum, and "Food is Where You Find It," by the Auckland Institute and Museum. Military Intelligence Service furnished copies of many of its unpublished reports on the subject by regional officers.

This was probably the only survival library in Washington, in spite of the fact that most of the materials could have been acquired by any Government agency. A special committee appointed by the Joint Chiefs of Staff to assemble such books, curtailed its activities after seeing the Board's collection. The survival library was consulted frequently by the writers of many manuals and pocket guides, and contributed to the preparation of the Board's own booklet, "Survival on Land and Sea."

Photographs

The staff handled many photographs but did not maintain any special files. Most photographs were turned over to the war agencies immediately, or returned to their owners. Exceptions were illustrations on the subject of survival and Dr. Collins' personal collection of Arctic photographs. Because many agencies were better equipped to copy and file photographs, the Board was able to concentrate on sources rather than actual prints.

Cross-Cultural Survey File

The Cross-Cultural Survey was established in 1937 by the Institute of Human Relations, Yale University, under the supervision of George Peter Murdock, professor of anthropology. Its original purpose was to assemble and organize the literature on primitive peoples of the world. When the United States entered the war, the Survey was revised, and, after consultation with the Navy, concentrated on the literature on the Japanese mandated islands of Micronesia and other Japanese possessions. In 1943 the Navy took over the work of the Survey, still under the supervision of Dr. Murdock, now a Commander, USNR. The Ethnogeographic Board, through arrangements with the Navy and the Institute of Human Relations, became the depository of a copy of the file in order that Government war agencies might have access to these valuable materials.

The Survey file contains full abstracts from over 1,000 books, reports, and articles on Micronesia, Formosa, the Ryukyu, Izu, and Kurile Islands. Foreign language materials are translated into English and everything is typed on 5×8-inch cards and filed by area, topic, and subtopic. The file contains approximately 70,000 cards, exclusive of reproductions of maps and illustrations. A simple printed guide makes it possible to assemble information on the 295 main topics with ease and rapidity.

The Cross-Cultural Survey's staff used the files to prepare a series of "Strategic Bulletins of Oceania" which were widely distributed by the Board. After 1943 similar bulletins were prepared for, and distributed by, the Navy Department.

The Director issued a mimeographed statement which described the files and invited all agencies to use them. The response has been continuous, particularly by the Army, Navy, Office of Strategic Services, and the Foreign Economic Administration. The first interest was predominantly military, but more recently the files have been consulted for information on forests, industries, peoples, diseases, and the like. These files will continue to be important as a source of background information, even in the postwar period. Although the Board assisted the Government representatives in their consultation of the survey, it made little use of the materials itself.

General

A few miscellaneous lists contain general information on the sources of regional motion pictures, and the letter files contain folders on many potential sources of information, such as professional societies, institutions, and individuals. In summation, the Board's experience shows that a rather extensive service operation can be conducted without any elaborate information files. Bibliographies, lists, and detailed files are not only time-consuming to assemble, but are apt to become ends in themselves. The Board preferred action to system. This was possible because of the close relationship of the "promotion" activities to other aspects of the Board. By keeping in close touch with what was needed, little time was wasted on side lines.

PROMOTION TECHNIQUES

One of the first requirements of a new organization is to establish connections which will make its services known. Promotion was a major endeavor of the Washington office during its first 6 months of operation. Ways and means of establishing relationships were discussed at the Board meetings. It was agreed that the Director should have a free hand in his official and unofficial relations with representatives of Government agencies, on the ground that any rules and regulations would only hamper him. The point was a good one, because it is easily seen how complicated rules restrict the service activities of many Government agencies.

The Ethnogeographic Board faced a dual promotion problem, namely, the establishment of contacts both with the Government and war agencies, and with academic institutions and scholars. Some techniques cover both fields, but on the whole the approaches are distinct.

It is axiomatic that the best publicity is successful and significant performance. The Board's standard activities, such as distributing mimeographed lists, preparing area reports, and sponsoring dinner conferences, served the secondary purpose of advertising its services. The availability of the Area Roster and the information service was also good publicity. However, these were not techniques aimed primarily at establishing public relations and consequently will be discussed elsewhere.

Government Relations

The Directorate had considerable success in establishing the Board in war-confused Washington in spite of marked competition from Government agencies, both old and new, which were making every effort to get themselves known and heard. The backing by four powerful and well-known Sponsors was highly important, first in establishing connections, and second in allaying suspicion that the Ethnogeographic Board might not be what it seemed. Although the promotion techniques were not particularly unique, they deserve to be examined for the record.

1. PERSONAL CONTACTS

The Director spent a large part of his time in the initial months meeting people in Government agencies and following up all leads. He was already widely acquainted with Washington from his previous post at the Bureau of American Ethnology from 1932 to 1937.

Being an anthropologist, he found colleagues in practically every Government agency. Members of that relatively small and intimate profession were in great demand because of their knowledge of areas outside the continental United States. The Director entertained at small lunches and at his home, and on each such occasion explained the nature of the Ethnogeographic Board and its services. He attended conferences arranged by the war agencies and the Sponsors, where he not only met new people, but also told how the Board might assist. The records show his attendance at 11 major conferences between December 1942 and February 1943. A name and address file listed those individuals known personally by the Director and considered to be potential customers or valuable sources of information. By 1943 the file contained over 400 names, representing every major military and Government agency.

2. LIAISON OFFICERS

The Board established formal liaison with the Army, Navy, and some of the war agencies. Although this was an old, established technique, it was still effective, as demonstrated by the cooperating committees. In May 1942 the Smithsonian War Committee had arranged with Military Intelligence Service for a formal representative and, when the Board was established, the services of this officer were immediately transferred to it. The Director made a similar arrangement with the Navy within the first 2 months. Liaison was also established with Air Intelligence, Army Map Service, the Office of Strategic Services, and the Surgeon General's Office and was discussed, at least, with several other agencies.

The technique of establishing such liaison with the Navy is an example. Following a visit by the Director, Naval Intelligence asked the Board to prepare a report on a Pacific area. The Navy was impressed by the quality of the report and the speed of the service. This gave the Director an opportunity to present an argument for the advantages of permanent liaison. Such appointments were more than gestures on the part of the Army and Navy Intelligence Branches. For example, the Army followed up with a memorandum "For the Chiefs, All Groups, Branches and Sections, MIS." This included a statement about the Ethnogeographic Board and the services it might render, and indicated the procedure for utilizing these. The liaison officers held frequent consultations with the staff, in which they presented requests from their offices and in turn took the Board's reports for distribution in their own branches. In this way the Board was able to anticipate many needs, and the military agencies were kept informed about the Board's materials and the projects under way. The Director could ask whether the Military would be interested in such and such a project and receive a direct answer. Furthermore, the liaison officers drew up outlines for the Board of the type of information needed, the form of presentation, and the time available for its assemblage.

Although in theory liaison should be effective with any agency, in actual operation the best results were obtained with Naval and Military Intelligence, particularly the former owing to the personal interest of Capt. Ellis M. Zacharias, Deputy Director of ONI, and the ability of the officers assigned to the Board, Lt. (now Comdr.) C. M. Terry and Comdr. Richard F. S. Starr. Liaison with other war agencies was never too effective, and was apparently impossible with the civilian agencies. This may be because the armed forces had the most urgent need for this type of area information, or perhaps it could be explained in the words of one of the Director's reports: "Civilian Government agencies, in Washington as elsewhere, tend to become self-sufficient within the limitation of the Bureau of the Budget." One generalization stands out clearly. The most valuable liaison officers were not those who best understood the work of the Ethnogeographic Board, but rather those who were thoroughly familiar with the organization and operation of the office which they represented. The Army seemed to feel that it took one anthropologist to understand another, which is perhaps true, but does not lead to the most effective service liaison. (This is intended as a sound generalization, and not as a deprecatory comment on the merits and abilities of the three commissioned anthropologists who served successively as liaison officers to the Ethnogeographic Board. These three would, I believe, agree with me.)

The possibility of naming a Washington staff member as a liaison representative to some agency was never elaborated, although two were appointed at the request of the Office of the Provost Marshal General and of the Emergency Rescue Agency of the Navy Department. The Board felt that it was amply represented elsewhere by its Board members and Sponsors.

3. PROPAGANDA

Once established, the Board prepared a mimeographed statement about its organization, membership, and purpose, and this was printed later as a small brochure. This statement was widely circulated in Washington and helped to make the Board known, if anyone in pamphlet-showered Washington found time to read it. The distribution outside of Washington was more limited. It was customary to include the brochure in each of the circular letter requests for area photographs or information, but there was no systematic coverage of the universities and scholars.

Two supplementary statements about the Board's services were also sent to many Washington agencies. One was a "List of Mimeographed Materials Available to National War Agencies upon Official Request to the Ethnogeographic Board." The other was a description of the World File of Area and Language Specialists, and the Cross-Cultural Survey file on the Japanese Mandated Islands in the Pacific. The true effectiveness of these is demonstrated by the numerous requests for the mimeographed materials, and the many representatives who appeared to consult the two files.

The publicity in newspapers and journals was limited. An article was prepared for Science, October 23, 1942, one for The Scientific Monthly, August 1943, and a general review was included in an article on "Smithsonian Enterprises" which appeared in Science, November 6, 1942. A news release through the Smithsonian press service reached many local papers in abbreviated form. This brought in a number of letters from world travelers, some of whom were sent questionnaires and added to the Area Roster. Periodic statements of progress were sent to the Sponsors who made summaries for their annual reports.

Two admirable qualities of the Ethnogeographic Board are that it did not seek flashy publicity (although some of the queries were tempting, e. g., "Are there snowshoes for horses?" and "What are the results of eating bearded seal liver?"), and that it was not jealous about credit. Many of its reports were published, in part or in whole, in Army and Navy service journals. The Board placed no restrictions on the use of these materials, although it did ask for the courtesy of a credit line. However, when this was not given, as was usually the case, no complaints were registered.

In over-all appraisal, the Board was successful in establishing wide and effective relationships with Government agencies, particularly those most likely to use its information services. However, if the Board had decided to undertake projects of a longer term, and more academic nature, once its information service had largely ceased, new promotion efforts would have been needed.

Academic Relations

The Ethnogeographic Board did not devise any special promotion techniques for establishing relationships with the academic institutions, but depended on its Board members, consultants, cooperating committees, and Sponsors. The articles in Science and The Scientific Monthly and the summaries in the annual reports of the Councils reached many scholars, and most of the leading professional societies were reached by correspondence, particularly in connection with the Area Roster. The brochure and some of the mimeographed materials were sent to a few institutions and scholars, although without systematic coverage.

Although a sizeable number of scholars learned about the Ethnogeographic Board, either directly or indirectly, the relationships were inadequate in that few appreciated the potentialities of this direct channel to Government for their scholarly programs and research. The Director was aware that the academic relations were unsatisfactory and brought up this subject at practically every Board meeting. The analysis of this problem involves much more than promotion techniques and, consequently, is reserved for a later discussion.

INFORMATION

One of the major functions of the Washington office during the first year and a half consisted of answering questions. The Area Roster and the information files were assembled for this purpose. The promotion techniques encouraged Government agencies to ask questions, and the staff even assisted in phrasing these so that they could be answered more effectively. Judging by the quantity of inquiries received, these services were amply utilized. Queries came in by telephone, official visitors, and by mail. The liaison officers forwarded others from many branches of the Army and Navy.

Some questions could be answered immediately, others involved several hours or days of search. The more substantial questions, and their answers, were kept in a card file, but there is no record of all the ones answered quickly. All letter requests and copies of answers were available, so that these, plus the card file, allow a general description of the nature, source, and variety of the questions, as well as the Board's technique and effectiveness in answering. The questions can be grouped into several major categories, although these are not always mutually exclusive, owing partly to the complex nature of some of the questions and partly to the fact that the categories themselves are somewhat artificial. However, the groups serve to illustrate the nature of the information service.

Personnel

The majority of the questions were, either directly or indirectly, about people. One-third of the requests listed in the card file were concerned exclusively with personnel, and many of the others asked indirectly about individuals with special knowledge or training. Some examples of these questions and answers have already been given in the description of the Area Roster. Some of the queries, however, could not be handled by quick reference to the roster, particularly if the qualifications involved went beyond the limited information included in the roster questionnaire. Various types of personnel inquiries are illustrated:

1. Specialists

Requests came in for people who could speak little-known languages like Motuan (Southeast Papuan dialect), or Fijian, and for individuals able to read Amharic, Japanese, or Hebrew script. One agency wanted a man who could check a phrase book in Pidgin English for West Africa. Most of the questions which involved linguistic abilities were answered by the Intensive Language Program staff or others at the American Council of Learned Societies.

2. Regionalists

Who were the travelers who had recently been to the Gilbert Islands, to the Japanese Mandated Islands, to Marcus Island, to Bora Bora in the Society Islands? Who might have motion pictures of the Arctic? What were the names of some individuals in Oceania who could be used as native informants? Most questions of this simple regional type could be answered by consulting the Area Roster.

3. Specialists and Regionalists

Some inquiries were for professional or specialized personnel who also knew particular regions. Some of these were general requests for geographers who knew the Arctic, Asia, or Latin America, or regional botanists who could aid in preparing the Army and Navy manuals. Others were for men with specific knowledge on the weather conditions in Alaska or navigation conditions in the Arctic. One call was for anthropologists who knew the peculiar forms of tattooing in the Casablanca area. Other examples: a Washington dermatologist familiar with tropical skin diseases; an expert on crocodiles in the Southwest Pacific; agriculturalists familiar with types of containers used for shipping out of North Africa; businessmen and engineers familiar with Japanese industries. Some wanted specialists who could check a manuscript on Arctic instruction for aviators; check the accuracy of regional films; assist in writing soldier's handbooks. Answers to most of these questions involved consultation with the Sponsors, the Smithsonian staff, and other professionals in Washington.

4. EMPLOYMENT

Many questions concerned qualified people for employment: A curator for the enemy-weapons section of the Quartermaster's Corps; civilian experts on the Arctic, desert, and Tropics for commissions in the Army Air Forces; people who could be sent to Portuguese East and West Africa by the Board of Economic Warfare; an editor of Latin American materials for the Joint Chiefs of Staff; a research analyst for the Balkans and East Section of Navy Intelligence. Some universities turned to the Board for names of teachers in the area-language programs.

5. EVALUATION

Besides suggesting candidates for certain jobs, the Directorate was called upon to evaluate the abilities and scientific standing of individuals being considered for jobs. Through the roster, the cooperating committees, the Sponsors, and many other sources of information, the Board was able in almost every case to furnish names and evaluations.

Sources

A second large category of questions is characterized by requests for sources of information. In general, the personnel category clusters around the question "Who?", the source category around "Where?". The Board's principal sources were individuals, committees, institutions, Government agencies, and, most important of all, bibliography. Dr. Collins' work of ferreting out significant area references has already been described and the usefulness of this bibliography is illustrated by the information service.

I. BIBLIOGRAPHY

The bibliographical references furnished by the Board cover a wide range of regions and topics. Both general and specific references were supplied for such diverse regions as Nunivak, the Aleutians, Honduras, Gambia, Formosa, Spitzbergen, Burma, Sokotra, Mauritius, Albania, Italian Somaliland, Dutch Timor, Nicobar, Gough, Celebes, and Tripoli. Most requests were for geographical titles, but a few involved specific programs, for example: Sources on the Aleutians for instruction of Army engineers; sources on Albania to aid in planning a child-care program; list of basic sources for establishing a foreign-area library at an Army Staff College.

Common requests were for books with regional maps, such as a map of Copenhagen showing the location of art galleries and museums, or large-scale maps of Germany which marked county and city boundaries. The Board did more than wait passively for requests. For example, Dr. Collins compiled a list of publications containing large-scale maps of the Netherlands New Guinea, New Britain, and other South Pacific islands, and presented this list to the liaison officers. This was also done whenever a book with unusually good maps or pictures of some little-known region was encountered. Many agencies asked for books with illustrations. Not all were limited to topography and beaches, as demonstrated by requests for good pictures of the Ainus of Japan and for illustrations of common insect parasites. Some requests were for both regional and discipline bibliographies, for example, on Siamese botany, on race, on African agriculture, and on the *Conus* genus of poisonous mollusks. Others wanted linguistic references on the Lingua Geral of Brazil, on Tibetan dialects, on Eskimo vocabularies, on Pidgin English, or on the distribution of languages in Europe.

In a few instances the inquiries were for rather specialized bibliographies. Some of these include: Publications with information on the financial organization of Japanese companies exploiting the mandated islands; bibliography on rocks and rock coloration for camouflage in the South Pacific; references on the food, clothing, and culture patterns of North Africa, particularly Tunisia, for making relief pictorial maps; books with information on Greenland's hospital facilities, educational facilities, police systems, and religious organizations; titles for data on acculturation through medicine men in Central America.

The Board was able to supply references for a large number of these varied topics from its files, or from its constant perusal of

Washington libraries. Some, however, were prepared for the Board by the cooperating committees and by individuals. Leila F. Clark, Smithsonian Librarian, prepared an extensive bibliography on Tripolitania, and Raymond Kennedy, of Yale University, furnished one on disease and health conditions in Netherlands East Indies.

Although the Board did its best, under the circumstances, to get satisfactory references in terms of the particular request, it is almost impossible to make any adequate judgment of the quality of the coverage. To say the least, no complaints were received, and there were many notes of thanks. However, some features distinguished the bibliographical service. Practically every request was answered with at least one reference and usually with several. Furthermore, the replies were sent with minimum delay. An example is seen in a letter from Dr. Collins to Lieutenant Starr dated June 25, 1943: "In response to your request of yesterday for literature on Italian Somaliland and adjacent territories, we are sending you nine issues of the Bulletin of the Royal Geographical Society of Italy containing articles on this area." This not only illustrates speed, but also another feature, namely, that the books themselves were often sent. If it were not possible to send the books, or if they were not wanted immediately, the Board indicated their location in Washington libraries and gave the call numbers.

As an aid to the requester, the bibliographies were annotated to indicate illustrations, maps, and general quality. When necessary, titles of pictures and sometimes significant passages were translated into English. As a general example, a list of publications on the Nicobar Islands was sent with the comment that the first four were best. A week later another reference was sent which was "even better than any of the first list." Good books would be called to the attention of the liaison officers. Finally the staff's area interest and knowledge provided a true understanding of the nature of such requests. In March 1943, Dr. Collins sent Lieutenant Terry eight numbers of "Mocambique Documentario Trimestral." These were selected because they illustrated and described cities, harbor installations, shipping, aviation fields, road construction, railroads, bridges, military maneuvers, etc. It was also noted that other numbers of the same review while containing some materials, were not so well illustrated. There is no doubt that this type of service was deeply appreciated by the Army and Navy.

2. INDIVIDUALS

The Board depended on specialized personnel as sources of information. Naming individuals who might have additional information has already been mentioned as a standard practice in answering requests. In some cases the Board got in touch with the specialists, in others this was left up to the requester. When the Army Air Corps asked for information on the topography and soil conditions of one of the Aleutian islands where a new air base might be constructed, the names of the few individuals who knew the island were furnished, so that the Air Corps could consult them directly. On the other hand, the Board itself got in touch with Mr. Cornelius Crane in answer to a request for his maps of the South Seas.

Three cases illustrate further how individuals were used as sources. Dr. Collins, in his library survey, came across a reference to a certain Japanese bulletin known to contain valuable material, but which was not to be found in any of the larger American libraries. He sent this information to the Military Intelligence together with a list of specialized libraries and individual scholars who might possess copies. A map of Iceland which showed political subdivisions smaller than counties was needed to complete the publication of a map on that area by the Army Map Service. The Board, through its connections, recommended Prof. Stefan Einarsson, professor of Icelandic at Johns Hopkins, and the map was obtained. A rush call for a picture of a Yangtze River steamer was answered in an hour by sending the name of a captain of the Marines in Washington who had been in charge of the Yangtze River Patrol.

3. COOPERATING COMMITTEES

Some requests for information were answered by referring to the cooperating committees as sources. For example, requests for a tribal ethnic map of Africa and for data on language distribution in Africa were handled by the Committee on African Anthropology.

4. INSTITUTIONS

In surprisingly few cases the scholarly institutions were cited as sources of information. Some requests were about institutions, for example, which universities were interested in the study of French Canadians, or which institutions specialized in Roman, Anglo-Saxon, Mohammedan, Russian, or Indic law. Requests for information on atabrine, or on color transparencies for training films on New Caledonia and the Solomons, were answered by reference to special institutions. On the whole, however, few requests were of such a nature as to require the services of the academic centers.

Facts

In some cases the Board furnished factual answers to questions. Apparently most of this type of information service was done by telephone, because the recorded questions and factual answers are neither numerous nor too impressive. To be sure, all factual questions about personnel and sources are excluded from this category.

The types of factual information supplied reflect the interests and specialties of the staff of the Washington Office and of the Smithsonian Institution. Questions about the North fell into Dr. Collins' special field. Those on anthropology could be answered by everyone in the Directorate. The Smithsonian's staff handled the questions on natural history and, through the linguist, J. P. Harrington, some questions on pronunciations of place names and words. A few factual answers came from the information files.

The Arctic group includes some strategic questions, such as the identification of the St. Lawrence Island coast line from air photographs, and the suitability of a certain island in the Bering Sea for an air field. Others are more ethnological: The linguistic, cultural, and physical relationships of the Kodiak and Aleutian Islanders; Arctic fishing; the construction of sod houses in the north; the dividing line between various Eskimo dialects; and what is the weight of a dressed caribou carcass.

The anthropological questions have the range and world coverage of a preliminary Ph.D. examination. How are blow guns made? Did the Northwest Coast Indians use fish or fish products in trade? What are the Indian methods of screening or other protection against mosquitoes? What tribes of Indians were in Iowa? What dialects are spoken in North Mexico? What are the tribes and languages of Angola, West Africa? Only one is still unanswered: the identification of the supposed ethnic or linguistic groups called Granish and Litvich.

The Smithsonian staff answered a variety of questions such as the distribution of wild hemp; the scientific name of the Australian bandicoot; the Baobab tree; and vampire bats and rabies in Trinidad.

Dr. Harrington and others aided in furnishing pronunciations of names in the Caroline, Marshall, and other Oceanic islands. Other questions about meanings, spellings, origins, and pronunciations were answered with the aid of a dictionary or published vocabulary—sources of information apparently unknown to the requesters.

A few miscellaneous questions were answered after a bit of search and consultation. Are the cotton warehouses in Alexandria fireproof? Are there any stamps or paper currency of the Formosan government which existed for 3 weeks in 1895?

Materials

Many of the requests could be answered by sending materials which the Board had accumulated or prepared. The types of lists and materials distributed by the Board are discussed elsewhere, so that here it is merely mentioned that the circulation was enlarged on the basis of special requests. The staff answered some inquiries by sending a copy of a report prepared for some other agency. Unless the requesting agency specifically restricted distribution, the Board considered all its reports available to any agency.

No special effort was made to accumulate files of maps and photographs, but, by the very nature of its activities, the Board came into possession of such materials. Through personal contacts the Board received from Amos Burg and Junius Bird a large series of South American pictures, all carefully labeled, which were turned over to the Army and Navy. Raymond Kennedy sent in a gazetteer and maps of the Southwest Pacific, and E. M. Loeb turned over photostats of his maps of the west coast of Sumatra. Archeologists sent in photographs of the Dodecanese and other Aegean Islands which were gratefully received by the Navy, and Dr. Mary Swindler of Bryn Mawr loaned a set of Greek maps which the Army Map Service for a long time had been trying to locate.

In some cases the photographs and maps received by the Board were reproduced in the Smithsonian photographic laboratory and copies sent to the Army, Navy, or Map Service. Usually, however, the originals were sent to the Army or Navy where copies were made. The correspondence involved in these transactions, the necessity of keeping track of the materials, collecting and returning them to the owners, proved too much for the small staff to handle conveniently. This difficulty was solved by the later arrangement, already described, of enclosing Army and Navy franks and asking the owners of such materials to send them in directly to the offices of Military or Naval Intelligence.

The Board also filled a number of requests for the originals of illustrations used in its own and in the Smithsonian publications.

Orientation

As a byproduct of the information service, the Board was able to assist in the orientation of individuals and agencies, an important function in the Washington confusion. In answering a specific question it was often possible to point out other agencies or individuals with similar interests. Some of the orientation was even more direct. The Federal Communications Commission was referred to the Office of the Coordinator of Inter-American Affairs and to the Latin American Division of the Office of Strategic Services for information on the distribution of Germans and Italians in Latin America. Dr. Collins explained to Navy Intelligence that he had not looked for the book *Java from the Air* since all the pictures had already been copied by the Navy, Army, and Office of Strategic Services. A man from the Board of Economic Warfare was told where he could find a copy of his own agency's African personnel list.

The Board was able to eliminate some duplications by timely information. A conference, which allowed examination of the Area Roster, convinced the Department of Commerce to cooperate rather than start a roster of its own. A Naval Training Division lieutenant who inquired about motion picture strips to use in training flyers, was informed of identical work being done by another lieutenant in the same Division. Many agencies were told to consult the Intensive Language Program, particularly when they were considering starting one of their own. The Board, on special request, furnished the Joint Editing Board of the U. S. N. and U. S. A. a list of all agencies working on the problem of survival. In one case the Arctic, Desert, Tropic Information Center brought in a list of proposed projects and asked the Board to check it for duplication of effort.

Individuals were assisted in going about their jobs. A man from the Office of the Coordinator of Inter-American Affairs was told how to go about getting a permit to allow Army Engineers to make some maps of Costa Rica. One officer, before going to West Africa was not only given pertinent mimeographed materials, but also introduced to several Government employees who knew the particular region. The Director commonly told Army and Navy officers about the services available to them through their own liaison.

The Board brought together people with similar interests, and thus stimulated new and useful work. The dinner conferences were most effective in this and important enough as a technique to merit separate description. However, there are other illustrations of this service. For example, the Board learned of the coordinated manuals on Arctic plants which were being prepared for the Canadian Army. Arrangements were made for a military officer to attend a conference on this subject in order to ascertain whether such manuals could not be prepared at the same time for our own army.

Placement

Inevitably the Ethnogeographic Board became a placement bureau for area specialists, particularly unemployed anthropologists. This service was conducted largely on a personal basis and not formally recorded. Undoubtedly many individuals received appointments through the good offices of the Board. However, this was not considered as a primary function, and it was recognized that the Councils, especially the Washington office of the Social Science Research Council, were in a much better position to handle this type of activity.

Advice

The Board sometimes assisted individuals and agencies in formulating or executing projects. This is exemplified by the advice on how to build up a comprehensive bibliography of agriculture in the Central Pacific islands; the best means for obtaining meteorological information for the Bering Sea region; and the methods of compiling sources of information on topography, that is, such things as questionnaires, analysis of published data, and the like. The Board also suggested ways and means of locating rare Japanese geological and geographical publications, and a complete set of Shibaura Review (of the Shibaura Engineering Works, Ltd., Tokyo).

Some sought the Board's opinion on such things as to whether a manuscript was worth publishing, whether it was possible to prepare anthropology books for pre-flight (high-school level) training, whether outlines for scientific study of such things as botany and geology would have morale value in remote army posts. The State Department even asked for a list of places which a Chinese scholar should visit in the Midwest.

In some instances the Board offered assistance as well as advice. Operation Intelligence wanted certain detailed information and photographs on foreign areas. The Director not only suggested that the American Museum of Natural History might be willing to undertake the assignment, but also confirmed this by a consultation with the Museum. The Weather Bureau wanted advice on how to get information on weather conditions in certain remote areas. Dr. Collins sent a sample of observations on Alaska taken from his own diary and added a list of names of others who might have similar data on many parts of the world.

One case illustrates advice followed by the actual execution of the project. Military Intelligence came to the Board for advice on how to test the linguistic proficiency of several officers before selecting them as Russian translators. The problem was complicated by the need for speed and by the fact that the testing would have to be done in the vicinities of Seattle, Camp Wallace, Tex., Rapid City, S. Dak., and Las Vegas, N. Mex. The Board undertook to do this. Names of competent testers in these four regions were supplied by the American Council of Learned Societies. The Assistant Director telegraphed the testers, stating the request, the dates, the hours. The tests were given and the reports made by telegram. The original request was received on November 28, 1942, and a letter thanking the Board for the job is dated December 2, 1942.

Analysis

The volume of the Board's information service is reasonably impressive. Some 460 question and answer records are on file, and it is estimated by the staff that the unrecorded questions would more than double this total. Furthermore, the great volume of this service was concentrated in the first year and a half. A simple graph of the recorded "spot" requests by 6-month periods shows a steady downward trend from the second half of 1942 to the first half of 1945. During the first six months recorded questions averaged about 28 a month, as against 5 a month in 1945.

Following the categories under which the information service was described, an analysis shows that personnel and source requests were the most popular (about 30 percent each), requests for facts and materials were next (about 15 percent each), and the categories of orientation and advice split the remaining 10 percent. It is impossible to estimate the amount of placement service owing to the lack of records. Some shift in emphasis can be noted in the 3 years under observation. In the first half of this period, questions about personnel definitely dominate. In the second half, sources lead, personnel is less important, and materials are more in demand. A shift is also noted in the nature of the questions, from immediate knowledge about war areas to interest in postwar planning.

A review of the agencies which submitted the requests for information shows immediately that the most extensive use of the service was made by the Navy and the Army, particularly the Intelligence Divisions. This can probably be attributed to the facts that the Board itself was most eager to serve these organizations, that the War and Navy Departments had the greatest needs for the area information, and that effective liaison was established from the beginning. All the emergency agencies made some use of the Board, principally in respect to personnel. Some of the civilian agencies did likewise but with less frequency. Outside of Government there were occasional requests from the Councils and the universities, and, rarely, an individual scholar. Again the outside requests were generally about personnel. On the whole the academic institutions had their own facilities for seeking bibliographical and factual information, and it is doubtful that the Board would have cared to handle many such requests for them.

The staff itself, with its Area Roster and information files, answered most of the questions. The Smithsonian's staff was second as a source of answers. In fact, many of the questions that were channeled through the Board would probably have reached the Smithsonian in any event. The Sponsors, particularly the American Council of Learned Societies, furnished the answers to some questions, and the cooperating committees handled a few. Only rarely was the Board forced to seek an answer outside of Washington. This can be interpreted either as a tribute to the versatility of the staff or as a reflection on the complexity of the questions. The former is naturally more flattering.

Evaluation

This description of the information service seems in many ways like an account of the 3 years' experience of a group of good reference librarians. In fact, some of the large museums might match the quality, quantity, and variety of the requests, and show an equally good record of obtaining answers. In over-all review, some of the questions were petty, some vague, and some a reflection of laziness on the part of the asker. Few questions really taxed the resources of the Board and its Sponsors. A majority of the questions could undoubtedly have been answered with equal competence in a dozen other places, particularly with the aid of an Area Roster similar to the Board's. Was there, then, a need for this service?

The answer lies again in wartime Washington. To be sure there were a dozen places where a question might be answered, and the

Board offered to find these rather than let it absorb the time of every Government agency and division. To be sure answers to many questions were more or less common knowledge to the sciences concerned (a factor which made the Board's job relatively easy), but the sciences have seldom summed up their knowledge in simple and convenient form.

The Board offered a central location for obtaining answers to questions on areas and area personnel. It placed no restrictions on the use of its services for any Government agency, or any individual within it. Almost every question was answered with comprehension and speed, and with a competence comparable, at least, to any other quick source of reply. Furthermore, the Board did not question the validity of the request. Instead, it followed the old army policy, theirs not to reason why, theirs but to seek reply. The burden of proving the validity of the questions was deliberately handed back to the agency. Finally, the Directorate with its sponsorship was in a key position to evaluate sources, an advantage not shared by other information centers.

The effectiveness of the various categories of the information service can be roughly rated. The personnel service seems by far the most important. No other area roster was available, and through its use the Board was able to secure valuable materials, as well as supply the names of important consultants. The bibliographical service was certainly a convenience, and the particular merits of the way in which this was handled have been mentioned previously. The factual information, if we are forced to judge by the recorded examples, was not too impressive. Orientation was useful, although limited. It would take more than an Ethnogeographic Board to eliminate duplication of effort in Washington. The requests for advice were the most interesting, in that they presented the best opportunity for utilizing the scholarly attributes of the Board. Unpopular as advice is apt to become, it is unfortunate that the Board was not able to play a greater role in guiding the formulation of projects and procedures within its competence.

The information service made good publicity, and helps to account for the wide recognition which the Board received in relatively little time. Considered in this way, it is an effective technique which would be useful in a future emergency. The question of whether the information service was really worth while is left open. It certainly cannot be judged on its own merits, but should be considered in relation to the total activity of the Board.

DISTRIBUTIONS

The Board acted as a center for distributing mimeographed and printed materials to interested agencies in Washington. It has already been mentioned that duplicate reports were sent to more than one agency unless specifically restricted. Aside from these, in which the distribution was at best limited, the Board gave wide circulation to certain materials prepared by its staff or by its affiliated organizations. These items are described briefly by sources of origin.

Prepared by the Ethnogeographic Board

1. "Survival on Land and Sea." The preparation of this pocket-size, waterproof manual on survival was one of the major projects undertaken by the Board and will be described in greater detail later. The Board also gave some assistance to the Navy in its distribution.

2. Area (and Language) Notes. This mimeographed statement on area materials was sent to the teachers of area programs in the universities.

3. Partial List of Oceania Experts in Washington. The list was made at the request of one agency and then mimeographed for wider consumption.

4. List of Mimeographed Materials Available to National War Agencies upon Official Request to the Ethnogeographic Board.

5. I. Cross-Cultural Survey File on the Japanese Mandated Islands of the Pacific. II. World File of Area and Language Specialists. This statement describes the Board's two major files and invites Government agencies to consult them.

6. Reports on Area Studies in American Universities. The area studies survey is described in detail under Projects. Reports on six universities have been completed and distributed.

7. Conference on Bolivian Indians. The Board sponsored this problem conference, to be described as a Project, and mimeographed the resulting report.

Prepared by the Cooperating Committees

1. Personnel List of Africa, Installments I-VI. A series of personnel lists were prepared by the Committee on African Anthropology, and distributed by the Board. These are compilations "of persons familiar with the colonies, territories and countries of Africa and adjacent islands, with their address and data on their experience." Each installment arranges the names of specialists first

by area division, then alphabetically. The information covers dates of travel, capacity, linguistic ability, area materials, address, age, and occupation. The sixth installment is an index to names, regions, languages, occupations, and materials.

2. Military Manpower of Africa. The Africa committee also prepared this special report on manpower resources.

3. Personnel List of Oceania, Installments I-VI. The Committee on the Anthropology of Oceania prepared a series of personnel lists similar to those on Africa but without the final index.

4. Personnel List of Asia. The Oceania committee assembled this partial list as a byproduct of its principal survey of Oceania.

5. Asiatic Geographers. The Committee on Asiatic Geography compiled a list of professional geographers with Asiatic field experience. The list gives name, address, age, degrees, and travel.

Prepared by Institutions and Individuals

1. Strategic Bulletins of Oceania. These bulletins were compiled by the Cross-Cultural Survey, Institute of Human Relations, Yale University. Seven were completed and with one exception distributed through the Board. The titles of the seven bulletins are:

   1. Gazetteer of the Marshall Islands.
   2. Meteorology of the Marshall Islands.
   3. Emergency Adaptations in Melanesia.
   4. Seaplane Landings in Northern Dutch Guiana (not for distribution).
   5. Food and Water Supply in the Marshall Islands.
   6. Distribution of Diseases in Melanesia.
   7. Meteorology of the Caroline Islands.

2. Resources of the Smithsonian Institution Library. A statement which describes the size, location, and general contents of the library.

3. "The Linguist as a Teacher of Languages," by Mary R. Haas, reprinted from Language, vol. 19, No. 3, 1943. The Board obtained reprints of this article for distribution to the teachers of area and language programs in the universities.

Series which the Ethnogeographic Board Assisted in Distributing

1. Smithsonian Institution War Background Studies. Twenty-one numbers of this series appeared between 1942 and 1945. Since these are readily available in libraries the titles are not listed here. The accounts cover regions, peoples, and natural history of world areas. The Board transmitted many requests for numbers in this series to the Smithsonian, particularly from the Army and Navy.

2. Smithsonian Mimeographed Materials on the Southwest Pacific. A series of short statements about plants, mollusks, birds, butterflies, and the like, was brought to the attention of interested agencies by the Board.

In total the Board had 35 separate documents of its own for distribution and was allowed to assist in the distribution of some 35 others. These were sent out in sizable quantity to Government agencies and individuals in the Director's Washington card file. Other copies were supplied on written or oral request.

The distribution of some of these documents is tabulated in the accompanying table (No. 2). The Army and the Navy were the principal recipients of most of these, especially the Strategic Bulletins of Oceania. Other war agencies showed most interest in the personnel lists. The civilian agencies seldom asked for more than file copies of anything. The Sponsors received copies of everything, and outside of Washington a few individuals and libraries requested or were sent some of the materials, but the distribution was decidedly limited. Members of the cooperating committees naturally received copies of the lists which they had prepared but seldom any of the things prepared by others. More attention to extra-Washington distribution might have inspired the production of equally valuable materials.

TABLE 2.—*Materials distributed by Ethnogeographic Board*

June 1942–March 16, 1945

	Personnel Lists of Oceania						Personnel List of Asia
	1	2	3	4	5	6	
MIS	55	40	47	35	43	48	21
Army	9	9	9	9	9	9	5
ONI	43	44	41	48	46	50	27
Navy	11	11	11	1	2	2	10
Air Intelligence	10	13	5	3	3	3	5
Air Corps	2	2	2	2	2	2	
War Agencies:							
BEW (OEW)	12	12	12	12	12	11	10
FEA	1	1	1	1	1	2	5
OSS	37	32	32	24	23	26	32
OWI	1	1	1	1	1	1	3
WRA	1	1	1	1	1	1	1
Gov't agencies and departments	6	6	6	7	8	7	5
Others:							
Sponsors	11	11	11	12	12	12	9
Individuals	15	13	13	15	15	15	10
Total	214	196	192	171	178	189	143

TABLE 2 (*continued*).—*Materials distributed by Ethnogeographic Board*

June 1942–March 16, 1945

	Personnel Lists of Africa						Strategic Bulletins of Oceania					
	1	2	3	4	5	6	1	2	3	5	6	7
MIS	50	51	53	62	65	73	89	95	93	86	73	110
Army	9	7	7	6	8	6	9	6	4	4	3	2
ONI	43	43	43	42	61	60	81	85	92	107	124	83
Navy	..	..	..	..	..	..	6	6	4	3	6	3
Air Intelligence	3	1	1	..	..	..	..	..	..	..	..	1
Air Corps	..	..	..	..	..	..	2	16	2	..	..	..
War Agencies:												
BEW (OEW)	7	7	8	6	6	3	5	5	6	3	3	3
FEA	1	1	1	1	1	1	1	1	1	1	1	1
OSS	32	28	30	3	13	27	17	16	4	8	8	9
OWI	3	3	3	3	3	3	1	1	1	1	1	1
Gov't agencies and departments	10	10	10	10	10	10	17	13	12	10	10	13
Others:												
Sponsors	13	11	11	10	10	11	12	10	11	14	11	12
Individuals	23	22	26	22	16	14	20	21	18	16	13	16
Total	194	184	193	165	193	208	260	275	248	253	253	254

TABLE 2 (*continued*).—*Materials distributed by Ethnogeographic Board*

June 1942–March 16, 1945

	Bolivian Indian	Oceania Experts in Washington	Resources Smithsonian Library	Asiatic Geographers
MIS	2	56	35	3
Army	..	7	1	5
ONI	..	41	15	..
Navy		6	3	..
Air Intelligence	..	2	..	1
Air Corps	..	3	..	..
War Agencies:				
BEW (OEW)	10	12	5	6
CIAA	13	1	2	..
FCC	..	..	3	..
FEA	..	..	3	2
OSS	12	19	25	30
OWI	..	4	3	2
WPB	..	1	..	..
WRA	1	2	1	1
Gov't agencies and departments	6	30	28	7
Others:				
Sponsors	13	23	9	9
Individuals	37	29	9	17
Total	94	236	142	83

Grand total........ 4,518

To be sure, most of these lists and reports were prepared for the use of Government military and war agencies, and widespread distribution was discouraged by the FBI, which tried to insist on limiting distribution to official requests.

The Board's distribution service was well developed in the local sense, and interested agencies received everything that they could utilize. However, it is unfortunate that there was so little to distribute. Thirty-five items is certainly no sample of the scholarly resources of this country.

REPORTS

Besides furnishing information of the kind described and distributing prepared mimeographed materials, the Board undertook certain assignments of a larger scale which called for the preparation of reports. The dual function of the Ethnogeographic Board, to answer and to sell, is again reflected here. Some reports were prepared on the basis of written requests from the Government agencies, and others were prepared by the Board on its own initiative and then presented to the agencies. Behind this service was the concept that while exigency called for brief and hurried answers, many of the problems were worthy of fuller and more exact treatment and should, consequently, be farmed out to scholars. Unfortunately this sound principle was seldom put into practice.

Some of the longer reports were prepared on the basis of written directives. Both the Army and Navy Intelligence presented outlines of the types of information which they desired for various regions, and the Bureau of Medicine and Surgery did the same. They are heavily weighted on information of a strictly military nature and take no account of the abilities and limitations of scholars. (See samples of these outlines in Appendix D.) Undoubtedly many more reports could have been handled if the division of labor had been adequately defined. During the first year and a half, 37 reports were completed. These fall rather clearly into four categories.

I. STRATEGIC AREAS

Thirteen items are described in one of the Director's statements as "confidential reports on areas of strategic importance." These refer to the Bering Strait region, Seward Peninsula, St. Lawrence and Nunivak Islands, Alaska, and Kamchatka; the eastern Netherlands East Indies, the Moluccas, and Netherlands New Guinea in the Pacific; Rodriguez Island in the Indian Ocean; and the Strait of Magellan.

All the Alaska reports and the one on Kamchatka were prepared by Dr. Collins, a specialist on the north. The first two Alaska reports were prepared at the request of the Navy shortly before the Ethnogeographic Board was established. Based largely on Dr. Collins' field observations, they describe and illustrate with photographs and maps parts of the still uncharted and little-known coast lines of the two islands. The reports were given to the Army Air Corps on June 30, 1942, when Dr. Collins was called to a conference in General Arnold's office. At the time there seemed a possibility that one of the islands had been occupied by the Japanese. The other two Alaska reports, accompanied by 209 photographs, describe the Bering Strait area, with primary emphasis on terrain suitable for airfields. All other known sources of information, both personnel and literature, are given in these reports.

The most impressive documents are the three on the eastern Netherlands East Indies. Military Intelligence asked the Board to furnish a detailed study of the topography and ethnography of Halmahera and adjacent Islands, Ceram and Boeroe, Kei Islands, Aroe Islands, Timor, and the string of islands eastward of Timor. The request was made on June 13, 1942, and the final report was needed before August 1. The Director turned this assignment over to Raymond Kennedy, of Yale, one of the few in the country capable of handling it. The Army outline called for:

I. Topography (with map-tracings or photostats):
   a. General description.
   b. Main ridges, elevations, and physical divisions.
   c. Beaches—detailed descriptions, etc.

II. Ethnography:
   a. Linguistic and ethnic groups.
   b. General living conditions.
   c. Attitudes
   Etc.

The first section (52 pages) was sent in by July 20, and the second section (50 pages) by August 11. The quality of these reports was so impressive that a follow-up request was made immediately for a more detailed description of the geographical features of the Aru, Tanimbar, Kei, and Banda Islands. This resulted in an additional report of 55 pages. This report, like the other two, utilized all available sources in the literature and described coast lines, anchor-ages, possible landing beaches and sites for airplane landing, forests, swamps, trails, and other topographic features. Maps were not included, but sources were indicated. The staff obtained the books, had the maps reproduced by the Smithsonian and Military Intelligence, and attached them to the report.

Another important report was prepared by M. W. Stirling, Chief of the Bureau of American Ethnology, on the Moluccas and Netherlands New Guinea. This contains valuable geographical data, photographs, maps, and notes of a very practical nature based primarily on a field trip made by Dr. Stirling in 1926.

The remaining reports on strategic areas are composed of bibliographical references, pertinent quotations from the literature, general summaries without much detail, and photographs with titles for identification.

In résumé, 11 of the major reports total 275 pages, or an average of 25 pages each but with a range of from 4 to 55. Most of them are illustrated, and all have the virtue of being produced within short deadlines. If judged objectively instead of in terms of the immediate military need, only the Kennedy and Stirling reports have sufficient merit to warrant publication when declassified from the confidential list.

2. SURVIVAL

Ten of the items are described as "reports on survival in the Pacific region." The titles of some of these reveal their nature:

- Sago Processing.
- Seafood in the Indo-Pacific Area.
- Birds and Animals as a Source of Food in the Indo-Pacific Area.
- Tropicana ("Dangers of the Tropics").
- Trematode Diseases and Their Molluscan Intermediate Hosts in the Islands of the Southwest Pacific (an important contribution).
- Obtaining Water from Vines.
- The Stingarees, Much Feared Demons of the Seas.

These were prepared by the Smithsonian staff or others outside the Board. They were illustrated by drawings or photographs and edited by Dr. Roberts into simple, direct English so as to be of service to the field forces. The 10 reports total 128 pages, with a range of from 2 to 21. Most of them were published in one or more service journals, such as Tactical and Technical Trends; Arctic, Desert and Tropic Information Center, Informational Bulletin; ONI Weekly; the Marine Corps Gazette; and the Air Pilot Manual of the Pacific Islands.

The Board placed no restrictions on the use of these articles, although it did ask to read galley proof and suggested that a credit line and the author's name would be courteous. In fact, the Director constantly had to struggle to keep these practical survival articles from being classified as restricted or confidential. For example, one article which the Army marked confidential was "How to Identify Stale Fish." Confidentially, it stinks, said the Director, and tried to get it declassified. The humor is tempered when the weeks of struggle to achieve this are recalled.

3. EDUCATIONAL

Five somewhat miscellaneous reports consist of outlines for quick identification, statements on how to do things, and the like, as the titles indicate:

Oceania, a Tabular Outline. (The races, languages, and attitudes of the natives in each of the Pacific Island groups, in tabular form.)

Memorandum Concerning the Possible Use of Wooden Signal Drums in Jungle Warfare. (All that remained of a general request on the value of primitive methods of warfare for modern jungle fighting.)

Quantitative Distribution of Chinese in Southeastern Asia (living outside China) with Numerical Tables Regarding Dialects Spoken.

Coral Reef Navigation. (Some practical notes.)

Japanese Physical Characteristics versus Other Orientals. (Some notes on identifications.)

4. PERSONNEL AND SOURCES OF MATERIALS

The remaining nine reports are lists of specialized personnel who might have photographs, maps, or other materials for various areas. All but one of these have already been mentioned in the discussion of the use of the Area Roster. The exception was a request for a list of American and British expeditions to the Southwest Pacific since 1920. This involved Dr. Collins in a bit of library review of Museum Director's reports and notes in scientific journals.

The following summary gives a clear picture of the sources of report requests:

Military Intelligence Division	6
Other Army Divisions	5
Office of Naval Intelligence	6
Other Navy Divisions	3
Air Intelligence	3
Originated by Ethnogeographic Board	14

In brief, only the Army and Navy made use of the Board's report service, although it was in no way so limited by policy. Apparently the Government agencies were either unaware of, or not interested in, this function of the Board. Nor did the situation ever arise whereby a Council or academic institution asked the Ethnogeographic Board to prepare a report on some aspect of Government.

The Board was not forced to go far afield in preparing its reports. Fifteen were written by the staff itself. Another 12 were handled by the staff of the Smithsonian, 2 by committees of the National Research Council, and 1 by the Office of the Geographer of the Department of State. Only 6 were sent outside of Washington, and all of these to one place, namely, Yale.

The reports were sent to others besides the requester unless specifically restricted. In most cases everything was sent voluntarily to the Intelligence branches of both Army and Navy and to other war agencies on request. The published survival articles naturally received a wide distribution.

The Board's report service was well received. The Kennedy and Stirling manuscripts provoked a truly enthusiastic response and the letters of acknowledgment show that the other area reports were appreciated. The survival articles were considered significant enough for rather extensive publication. The remaining reports, about a fourth of the total, were of more limited value.

The chief criticism of the report service is its limitation. Thirty-seven reports, regardless of their individual merits, are but a small number. Furthermore, the staff of the Board and the Smithsonian, and a few professionals at Yale, competent as all of them may be, do not represent an adequate sampling of the scholarly resources of the country. The Board was, of course, faced with the problem of how many and how large jobs it could handle without becoming a small branch office of the Army or Navy. However, the report service should have been one of the most effective means of bringing the specialized talents of many scholars into focus on the war effort. The Board members did nothing to assist the Directorate to increase its report service.

CONFERENCES

The American Council of Learned Societies and the Social Science Research Council have for many years used the informal luncheon or dinner conference as a technique for making their activities known and for bringing together individuals with common interests. Some of these conferences are oriented around a discipline, or a specific problem, others are regional. For example, the Joint Committee on

Latin American Studies at each Washington meeting has arranged a luncheon with various Government officials interested in Latin America. This has served the dual purpose of enlarging the scope of the discussion and of making the work of the committee known to the Government.

When the Ethnogeographic Board was founded, the Councils urged that the conference technique be utilized as a means of cutting across departmental lines. The Director was invited to attend a number of conferences in order to learn the pattern, and also to speak for the Ethnogeographic Board. During its first year, the Board arranged 10 major conferences of its own, based specifically on regions. Individuals from various Government agencies and from academic institutions were invited to each. The primary purpose was orientation, that is, introducing Government people to each other and to scholars with corresponding interests. At each dinner some problem of a regional nature was presented for discussion. This conference technique proved particularly useful in a wartime setting but would certainly be equally useful in any period. Consequently, it seems worth while to describe the conferences sponsored by the Ethnogeographic Board as a basis for an over-all analysis. The description follows a chronological order.

1. AFRICAN SPECIALISTS (SEPTEMBER 21, 1942)

A dinner was held at the Cosmos Club for the purpose of bringing together representatives of Africa sections of different Government agencies. Sixteen people attended, representing, informally, the Board of Economic Warfare, Office of Strategic Services, Military Intelligence, Commerce, State, and the Councils. The invitations were issued by telephone, and no agenda was prepared. No records of the discussion were kept because the meeting was considered confidential. The Director made a few notes on the attitudes of the participants for future reference.

2. FAR EASTERN GEOGRAPHERS (OCTOBER 5, 1942)

George B. Cressey, of Syracuse University, felt that there was a need for an Asiatic Geographical Institute. The Board offered to arrange a dinner conference to explore and discuss the possibilities. Twenty-four attended, representing the Office of Strategic Services, Board of Economic Warfare, State, Army, Navy, Lend Lease, the

Institute of Pacific Relations, the Councils, and several universities. Everyone invited received the following letter in advance:

Dear Sir:

On Monday, October 5, 1942, the Ethnogeographic Board, at the suggestion of the American Council of Learned Societies, is holding a dinner conference of Far Eastern geographers. We hope to stimulate discussion around the following points:

1. What are the immediate needs in the field of Oriental geography?
2. Would it be worth while to make an attempt to establish a Central Institute of Oriental Geography?
3. Are there any specific tasks in this field which might be planned and administered from Washington but undertaken and carried through at various universities, libraries, and other institutions throughout the country?
4. Given the acute shortage of Oriental geographers, could a training program be devised for the emergency?
5. And any others which may seem worthy of discussion.

You are cordially invited to attend this dinner which will be at 7:00 o'clock at the Cosmos Club (cocktails at 6:30). We would appreciate hearing at the earliest possible opportunity whether it will be possible for you to attend. If you care to suggest any addition to the list of those invited which accompanies this letter, please do so.

Very sincerely yours,
Wm. Duncan Strong, *Director.*

As a direct outcome of this conference a Committee on Asiatic Geography was established in the National Research Council for continued exploration of the problems raised.

3. NETHERLANDS EAST INDIES DINNER (OCTOBER 12, 1942)

Following a preliminary discussion with Cora DuBois and others interested in the East Indies, the Director invited 15 people for a discussion dinner at the Cosmos Club. Among the attendants were representatives of the Army, Office of Strategic Services, Board of Economic Warfare, Tariff Commission, Library of Congress, Bureau of American Ethnology, Institute of Pacific Relations, East Indies Institute, Netherlands Embassy, Board of Economic and Financial Affairs in Netherlands Surinam and Curaçao, Chief Liaison for Netherlands East Indies in Australia and New Zealand, and the Councils. No record was kept of the informal discussion.

4. NEAR EAST DINNER (OCTOBER 19, 1942)

At the instigation of Philip W. Ireland, Department of State, the Board and the American Council of Learned Societies joined to give a dinner at the Cosmos Club for 19. The purpose of the conference was to discuss such Near East problems as personnel lists, the value of a directory like the "Fairbank Directory of Organizations in America Concerned with China," and the possibility of an Institute for Oriental Studies. Guests represented the Army, Navy, State, Office of Strategic Services, Board of Economic Warfare, Agriculture, Library of Congress, and one university. Following this conference a group was formed to promote the establishment of an Institute for Oriental Studies.

5. DINNER FOR PROF. PAUL RIVET (DECEMBER 30, 1942)

The Board arranged a dinner in honor of Prof. Paul Rivet, noted French scholar and director of the Musée de l'Homme at the Trocadero. Eighteen individuals were invited representing Latin American and Free French interests. General problems were discussed.

6. ETHNOGEOGRAPHIC BOARD DINNER (JANUARY 9, 1943)

A dinner for the staff, liaison officers, and respective wives served to unite the organization of the Washington office.

7. LORD HAILEY DINNER (FEBRUARY 13, 1943)

The Washington visit of Lord Hailey, expert on Colonial Africa, gave occasion for an informal dinner conference to discuss colonial problems. Nineteen attended, representing the Navy, Army, State, Office of Strategic Services, Board of Economic Warfare, and the American Council of Learned Societies.

8. POSTWAR NEEDS IN ANTHROPOLOGY (APRIL 12, 1943)

The National Research Council asked the Board to call an informal conference of six anthropologists to discuss future needs in that field. This meeting resulted in two general statements for circulation among the profession.

9. LAND TENURE PROBLEMS (APRIL 28, 1943)

At the suggestion of Willard Z. Park, Office of the Coordinator of Inter-American Affairs, the Board and the Social Science Research Council held a dinner for a general discussion of land tenure problems, particularly in Latin America. Sixteen attended, representing the Army, Office of Strategic Services, Board of Economic Warfare, Agriculture, Office of the Coordinator of Inter-American Affairs, Department of the Interior, Smithsonian, and the New School for Social Research. Dr. Park acted as chairman and kept informal minutes.

10. COLONIAL QUESTIONS CONFERENCES (APRIL 20, 1943; MAY 4, 1943; MAY 11, 1943)

This series of three conferences was arranged by the Board and the Analysis Section, Military Intelligence Division, G-2. These were all-day conferences, and at the close of one session the Board invited the group to be its dinner guests. The discussions were directed toward broad colonial problems. The first session was devoted to Oceania and Indo-China; the second, to West and Equatorial Africa; and the third to general problems. About 20 people attended each session, although the representatives were not identical at all three. The Army, Office of Strategic Services, Board of Economic Warfare, State, Tariff Commission, Commerce, and Archives, were always represented, and some special speakers from the universities were invited.

A detailed agenda for discussion was sent out in advance of each meeting. For example, the discussion outline for the second session was the following:

I. Strategic importance of West Africa.
II. Economic importance of West and Equatorial Africa.
   A. Commerce.
   B. Investments.
   C. Aviation.
   D. Access to raw materials.
III. The question of nationalism.
IV. The possibility of international controls.

At each meeting the major topics were first introduced by three speakers and then opened to general discussion. All discussion was considered confidential, but detailed minutes were kept. At the end these were summed up in a confidential document entitled "Political Possibilities in the Relation of the United States to the World's Colonial Systems."

The dinner conferences held by the Board were very successful in their primary purpose of bringing together people with mutual interests. Specialists in one agency met colleagues in another agency, and these introductions were frequently followed by personal meetings and discussions. Furthermore, the conferences were excellent publicity for the Board in its early days. Restrictions on food and restaurant facilities made it impossible to continue the dinner conferences after the first year. However, the need for orientation is constant in Washington, even though a bit more obvious when the confusion is greatest. Regional problems are still abundant, and their solution depends on keeping the various specialists in touch with one another. Moreover, if the problem is considered the primary factor, there is even greater justification for renewing such conferences as soon as conditions permit.

Some general observations on the conference technique grow out of the Board's experience. A non-Governmental agency can arrange a conference without getting involved in the suspicions and rivalry of the agencies themselves. However, such a group must have sufficient prestige to be assured that its invitations will be accepted. The Board relied at first on the prestige of its Sponsors, although later it was able to operate independently.

An advanced statement about the purpose of the conference and the major topics for discussion has definite advantages. The outline should be kept broad and flexible but be serious enough to attract interest. If the problem is too limited, many of those invited may refuse because of lack of interest or because it lies outside of their specialty. The detailed problems should grow out of the conference as topics for follow-up discussions. It is advisable, especially for orientation, to send an advance list of the names and affiliations of those who plan to attend.

A good chairman is important. Although the Director of the Board was able to assist at all times, some of the conferences were on fields outside his special competence. It is usually possible to find some interested specialist who will assume the responsibility of leading the discussion. Special speakers are useful for introducing a topic, but conferences of this kind should avoid too many or too lengthy speakers, since the purpose is primarily exploratory. The guests should be chosen because of their abilities and interests, rather than because of their affiliation. If this is clearly understood the discussion is freer, since no one is constrained on the grounds that he must speak as an official representative of some agency.

The ideal number for such a dinner conference is around 18. Many less than that makes it too intimate and does not bring in enough new people. Many over that makes open discussion difficult. The number should be such that a guest can meet, identify, and remember everyone present, and if the number is too large, no one bothers to try.

Probably records, such as minutes, notes, or summaries, should not be kept for the initial meetings. Discussion is freer among strangers if the meeting is closed, and if there is no fear of being held responsible for comments at a later time. In subsequent meetings the question of the type of record can be decided by the participants.

With the exception of the Colonial Problems Conferences, in which the Board was but a collaborator, no follow-up conferences were held. A single meeting is insufficient even for orientation, and in dealing with problems a series of conferences would be more advantageous than a single one. The follow-up conferences need more careful planning and selection of participants. It is not difficult to determine at the first meeting which guests are contributors and which essentially dead weight. A blanket invitation to reconvene at a later date blocks the possibility of eliminating participants and makes it difficult to add new guests without overloading the practical size of the group. Consequently even follow-up conferences should be by renewed individual invitations. The point may seem obvious, but the mistake is commonly made.

The above suggestions apply to dinner conferences aimed primarily at stimulation and exploration. The Ethnogeographic Board participated in some problem conferences, and called one of its own on the Bolivian Indians. This type of conference is described in a later section.

PROJECTS

Five major undertakings were of sufficient magnitude to be designated as projects rather than reports in the sense used here. All these involved either the cooperation of a number of specialists or were assigned to one man for execution. Each project is a distinct unit: The preparation of a booklet on survival; a problem conference; two surveys; and an analytical history. Besides these, the Board participated in a few large projects sponsored by other groups.

"Survival on Land and Sea"

At the request of the United States Navy the Ethnogeographic Board and the staff of the Smithsonian Institution prepared the 187-page, pocket-size manual "Survival on Land and Sea" (Publication Branch, Office of Naval Intelligence, United States Navy, cover map and 64 text figures, Washington, 1943. Not for sale). By December 1944, 970,000 copies had been printed on waterproof paper for distribution directly to the armed forces in the Pacific theater. The first edition of 200,000 was revised on the basis of criticism and experience before the second edition was issued. The Bureau of Aeronautics brought out a special edition which added 16 additional pages of specific survival information for airmen. Many subsequent books and booklets on survival have utilized portions of the text and many of the illustrations of this manual. In brief, this was definitely the most important project undertaken by the Board.

The Board's special interest in the survival problem has been pointed out in the description of the survival library, the survival reports, and the many spot questions about this subject. To reiterate, ethnologists were stirred by accounts of airmen dying of hunger and thirst in jungles because of ignorance of the edible food plants. This feeling was expressed strongly in a letter from G. P. Murdock to the Director, who in turn sent it on to both Army and Navy Intelligence headquarters. As a result the Office of Naval Intelligence requested the Board to prepare a series of short articles on survival in the Pacific area. The articles, prepared by the Board and the Smithsonian staff, and edited by Frank H. H. Roberts, have already been described.

Meanwhile, over 38 distinct sections of the Army, Navy, and war agencies were working independently on the preparation of larger survival manuals. Many individuals came to the Smithsonian and to the Board's office seeking information. The staff assisted by making all their materials available and, of even greater importance, by introducing the various agency representatives to each other. For some time the Board could do no more than act as a center of orientation and assist the various projects wherever possible. Still the survival manuals themselves did not in many cases appear, owing to standard red tape and interagency complications.

In the first month of 1943 the Navy Department, through the Bureau of Medicine and Surgery, officially requested the Board to prepare as rapidly as possible three separate manuals on jungle, desert, and Arctic survival. The Bureau offered to lend its services for some of the technical sections. Certain items were considered to be "musts," from the Bureau's point of view, and for these Dr. Roberts would be given all possible aid, or, if necessary, the Bureau would write them itself. The need for speed is indicated by the Bureau's guarantee that when the manuscript was submitted for review it would not be held for more than 24 hours.

Complications still continued in spite of the good faith. Eventually the Office of the Chief of Naval Operations took charge of the situation. After a number of conferences the following memorandum was dictated on June 8, 1943:

> The Ethnogeographic Board is to start at once to prepare an orientation and survival manual for the Navy (and possibly the Marine Corps) covering adaptation to the ocean, tropic, desert and arctic environment. This is to be a straight, highly condensed text, with irony or natural humor if fitting, but primarily factual. It will refer to a concluding section on all matters of technical medical care, and as the text is written these questions will be segregated for transmission to . . . the Bureau of Medicine. The work will be farmed out between members of the Ethnogeographic Board and the Smithsonian Institution. It will also include an index and a brief bibliography referring to such specialized survival manuals as that of Merrill, etc. Illustrations will be prepared by the Navy Department, and a list of desired illustrations and maps (for the covers) should be submitted . . . as soon as possible. In addition to the concluding section on medical care, the Navy Department will provide a section on "Navigation Without Instruments."

With this clear-cut mandate, calling for one booklet rather than three, the Board was able to proceed freely. The memorandum was sent on June 8. On July 21, a bare 6 weeks later, the Board and the Smithsonian had completed their part of the manuscript. This is remarkable speed when it is remembered that 15 members of the Smithsonian staff were contributors (see Appendix E), and that many of the extant survival manuals had to be consulted.

The manuscript was submitted to various branches of the Navy and to a selected number of civilian scholars for criticism and suggestions. The Navy added its sections, illustrations were prepared, and the first edition was in print by December 1943. Six months for a finished job of this type is a remarkable record.

The manual was well received. A naval captain wrote from the Central Pacific (June 26, 1944): "All officers who have read it are enthusiastic about the book. It should be gotten in the hands of every enlisted man and officer, and one copy put in each life boat and raft." The Director of Naval Intelligence wrote as follows (November 30, 1943): "It is, I believe, the most successful treatment of this difficult subject which has appeared thus far in the war. As such it may well be a determining factor in saving the lives of many men."

Conference on Bolivian Indians

At the first meeting of the Ethnogeographic Board in August 1942 the research function was discussed at length. Among other things, it was felt that various universities might be willing to sponsor certain problem conferences and to prepare special summary reports. Although requests for such services might come from a Government agency, this was not a vital necessity in that anticipation of needs was in itself important. Three trial projects were suggested at that meeting, and one was selected for immediate execution, namely, a conference on Bolivian Indians. This was not only considered to be important in itself, but would also serve as a model for other such projects.

The proposal was to assemble a number of scholars who had specialized knowledge of Bolivia in order to discuss those factors in the Indian's culture which were pertinent to the problems of (1) utilizing the Indians as industrial labor in the mines, (2) inducing the Indians to increase the agricultural output of Bolivia. The importance of the first problem was self-evident, particularly in 1942 when the production of tin was a paramount war necessity, when several groups were considering social insurance and security factors for the new tin contracts, and when the Indian laborers had still not expressed their own dissatisfaction with mining conditions by the series of strikes which followed later. Needless to say, it took merely an informal discussion to induce the Office of Strategic Services to request the project.

Since this project was to serve as a model, it was organized with overemphasis on formality. The Director wrote to the Provost of Yale University requesting sponsorship of the conference, the Ethnogeographic Board to cover all necessary expenditures. The Provost agreed. A letter of invitation was sent to five specialists (Bernard Mishkin, Weston LaBarre, Ernest Maes, Alfred Métraux, and Wendell Bennett), together with an outline of the purpose and of tentative points for discussion. The conference was held in New Haven in September 1942. Its chairman wrote up an account which included not only the concrete conclusions, but also a general résumé of Bolivian Indian culture as a background for nonprofessional readers. This was sent to the conference members for corrections and additions. The final report of 35 pages was mimeographed and distributed by the Board. Total time, 6 weeks; total cost, about $100.

Even the final report was considered to be only a preliminary statement intended to provoke further discussion. A total of 94 copies were distributed, as shown in the table on page 62. The report went to Government agencies with Latin American divisions, to the Sponsors, and to a number of individuals representing such organizations as the International Labour Office, the National Planning Association, and the Inter-American Indian Institute. Although intended as a sample of the type of work which academic institutions might undertake, only the immediate sponsor, Yale University, received a copy.

A number of polite letters acknowledged the report. Two took exception to some points and made valuable suggestions for a follow-up statement. All United States' members of the Joint Bolivian-United States Labour Commission, who went to Bolivia following the tin miners' strikes, carried copies of the report and its influence is reflected in their publication: Labour Problems in Bolivia (International Labour Office, Montreal, 1943). Dr. Maes submitted a special statement, which emphasized the concrete proposals of the conference, to the National Indian Institute, Department of the Interior. In spite of all this publicity, no one suggested a follow-up meeting or further discussion. Even the Ethnogeographic Board showed no further interest, although here was an excellent opportunity for one of its famous dinner conferences.

The research technique, if such a conference can be so labeled, was successful in the sense that it produced a preliminary report on an important problem. In spite of this, no others were held. An abortive attempt to hold a conference on "Ethnic Conditions in the Amazon Basin" was abandoned because the various persons asked did not see how to organize it. The Provost of Yale, in commenting on the procedure in a letter to the Director, thought that the universities would be receptive to proposals of this kind, but that there would be difficulties in finding key men sufficiently free from other duties to give much energy to such enterprises.

Survey of Area Studies in American Universities

The Ethnogeographic Board, with its area interests and academic affiliations, was in an excellent position to undertake an objective survey and analysis of the foreign area courses offered at many universities. Historically speaking, however, it got involved in such a survey somewhat accidentally.

At the September 1943 meeting of the Board the Director pointed out the desirability of hiring a competent assistant who could organize the regional materials acquired by the Board, obtain additional information from the universities and the scientific world, and make all this available to the area training programs of both universities and the armed forces. This idea was approved, and Elizabeth Bacon was employed for the purpose. Since many universities would have to be visited Dr. Fenton, whose work on the Area Roster was no longer too demanding, was also assigned to this task. The survey was initiated in January 1944.

Dr. Fenton was delegated to represent the Ethnogeographic Board at a 2-day conference in Pittsburgh at which the Provost Marshal General conferred with the university directors of the Civil Affairs Training Schools on the question of curricula for Europe. Later both the Director and Dr. Fenton conferred with the chief of the Army Specialized Training Division to inform him of their plans. He was far more interested in an appraisal of the area training aspects of the Army Specialized Training Programs and the Civil Affairs Training Schools. Although it would be difficult to give formal authorization for such a review, the Board's investigators would be given introductions and the other facilities to aid their work.

A list of the universities with important programs was drawn up, and the two surveyors started out with this dual concept in mind, namely, to offer concrete services in the way of materials and information, and to evaluate not only the programs but the whole concept of area training. This double purpose resulted in a certain amount of confusion about methods and objectives which was never adequately clarified by the Director.

In March 1944 the Rockefeller Foundation held a conference in Philadelphia on area studies in general, which was attended by the representatives of the Board and by individuals from a dozen universities. Because of the survey, the Board was asked to submit a report on the future possibilities of area studies. The confusion of objectives was clearly reflected in this report, and the need for reorganization was patent.

On June 1 Dr. Bacon accepted an appointment in one of the war agencies, and Dr. Fenton undertook the completion of the survey by himself. Under a new directive, the survey now aimed at an objective analysis of the way in which the universities operated their programs and of the thinking done by the faculties on the area approach. The reports were to be confidential and limited in distribution.

The survey has covered a total of 27 universities from the Pacific to the Atlantic coasts. Reports on about one-third of these have been completed, and six (California, Chicago, Cornell, Carnegie Institute of Technology, Grinnell College, and Harvard) have been mimeographed and are available for limited, not-to-be-published distribution. The information included has been gathered by personal visits, interviews, and participation, and by examination of the published articles, President's reports, and the like. The report on each university discusses the types of programs conducted; the faculty, both permanent and acquired; the resources of the institution, such as libraries and others; the planning and integration of courses; the administration of the programs; the teaching techniques; the actual curricula; and other aspects of the programs. The attitudes of the participating faculty and the administration is discussed, both in relation to the programs operated, and to the future of area studies. Throughout, an objective appraisal is inserted. When a report is completed in first draft, it is sent to the universities for review. This has caused some outbursts but has also produced additional information. The final reports, even though not emasculated, have been well received.

The first four accounts average some 36 single-spaced mimeographed pages each and go into considerable detail. Probably all 27 universities will not be written up, since a sampling will be adequate for generalizations and for a final over-all statement. However, all the notes have been systematically filed at the Board and are available for future consideration of area training. One general report was drawn up for the Army Specialized Training Division on the basis of a series of questions which they presented. On the whole, this survey of area programs stands out as a major achievement of the Ethnogeographic Board, and one of the few directed essentially at the problems of the academic institutions.

Since the survey was completed, Dr. Fenton has continued his analysis of the materials. One article, "Integration of Geography and Anthropology in Army Area Study Curricula," appeared in the Bulletin of the American Association of University Professors (vol. 32, No. 4, pp. 696-706, 1946). A full report, "Area Studies in American Universities," will soon be published by the Commission on Implications of Armed Services Educational Programs under the auspices of the American Council on Education, Washington. This will be approximately 80 pages, and will cover the above-described survey, and present a final appraisal.

War Document Survey

In June 1945 the executive committee considered a survey of war documents. During the war, Government agencies have accumulated valuable reports, special studies of foreign areas, photographic files, and useful research tools, such as dictionaries, maps, reprints, grammars, and the like. Many of these have already been declassified and others will be in the postwar period when the agencies are discontinued. The problem of the final disposal of such materials is of real concern to the scholars and academic institutions of the country. A copy of everything ultimately finds its way to the National Archives or the Library of Congress, but neither of these agencies is prepared to distribute the duplicates to academic institutions throughout the country. A preliminary survey of the quality and quantity of such materials is needed before intelligent action on the over-all problem can be recommended.

The Board wanted to initiate this extensive survey by employing some individual for a preliminary period of some 3 months. Several offers were considered, and one individual was actually assigned to the job. However, before he really began work he was taken into the State Department on a more permanent assignment. The Board then assigned Homer Barnett to survey the documents which concerned the Pacific area. This work, initiated late in 1945, is one of the continuing commitments of the Board. It has the advantage of uniting the War Document Survey and the temporarily abandoned Pacific Survey Project to be described later.

History of the Ethnogeographic Board

The present analytical account of the Ethnogeographic Board should be listed as a project, although one which needs little elaboration. At the fourth meeting of the Board in March 1944 the members discussed the desirability of an account which might guide the establishment of a similar organization in a future emergency. This proposal was accepted enthusiastically by the Sponsors who enlarged the concept of what such a history would cover. The Board debated at length the selection of an historian. The staff members felt too deeply involved to be objective about the Ethnogeographic Board. A person previously unfamiliar with the Board would have objectivity but might be overwhelmed by detail, meaningless if the framework were not appreciated. Whether the selection of a Board member solved the difficulties, remains an open question.

Participation

Besides its own projects, the Board participated in a number of others, some of which have already been mentioned in other sections. The Board assisted in the preparation of the manual "Jungle and Desert Emergencies," which the Air Corps places in all emergency kits. The Quartermaster General's Office worked with the Board on a "Reconnaissance Report on Concentrated Rations of Primitive Peoples." The Board cooperated with the American Council of Learned Societies on a program for training personnel in the Russian language. There are many others in which the Board played a minor role.

General

An over-all evaluation of these projects can be little more than a summation of opinion about each individual one. The merits of a project depend largely on the competence and integrity of the individual or group which undertakes it. The few projects sponsored by the Ethnogeographic Board have been competently handled and have resulted in contributions of long-term value. Only five were completed in a period of over 3 years, although several others were initiated and then discontinued. Most projects are expensive, and during a war competent personnel is difficult to find. Both factors help to explain why there were so few projects. If the formulation and direction of projects had been a function of the Board as a whole, more might have been carried out. The Washington office was too occupied by other activities to pay much attention to projects. The true need for a clearly defined division of labor between Board and Directorate is demonstrated in the next chapter which reviews the incompleted projects and the failures.

DEAD ENDS

The previous chapters have described the concrete activities of the Board; its files, materials, techniques, services, and projects. Some left-overs remain, some tag ends, miscellaneous in character, of projects and programs initiated but not completed, of research proposals neglected or rejected, of techniques considered but never actually tested. All these are brought together under the lugubrious title of "Dead Ends," because an examination of the contents of this figurative wastebasket is an important part of the analysis. Was anything thrown out that might have been of value? What were the blocks that killed some projects and made other proposals unacceptable? Some of the rejects are important enough for individual discussion; others can be grouped.

Pacific Survey Project

The most ambitious project undertaken by the Ethnogeographic Board was the organization of a comprehensive survey of all branches of science in reference to the islands of the Western Pacific Ocean. The Board struggled with this for a year, during 6 months of which the full-time services of Homer Barnett, research associate, were assigned exclusively to the program. Then the Board withdrew, leaving the project still in the discussion stage. An explanation of this requires a brief historical summary.

The Committee on the Anthropology of Oceania had considered the need for a survey at several of its meetings. The interest in this grew, so that the National Research Council called a conference on Pacific Scientific Problems in July 1943 to discuss the present and future needs of Government and scholars on the Pacific region. The conference included representatives of the Committee on Pacific Investigations, the Oceania Committee, the Ethnogeographic Board, and various Government agencies. The conference, after long deliberation, adopted a motion requesting the Ethnogeographic Board "to organize, implement, and make available a topical survey of the present state of scientific knowledge with respect to the various areas of the Pacific region for immediate practical use and as a basis for future scientific development in the study of the region."

This was no small order. The members of the Board admitted the importance of the project, but were careful to consider the limitations of responsibility which they could assume. It was finally agreed that the Board would act as a coordinating agency for the survey in the initial period, provided that a suitable executive could be found. It assumed no responsibility for publication, nor any financial obligation beyond the immediate administrative expenses.

The Board appointed a special committee on scientific research in the Pacific Island area, and secured the services of Dr. Barnett to act as the executive secretary. The first problem was to outline the scope and contents of the survey. It has not yet been solved. Some wanted a topical outline based on the earth, biological, and social sciences with suitable subdivisions. Others stressed the integration of data on cross-disciplinary lines. After several meetings, and numerous tentative outlines, the committee agreed that a scientific guide book, rather than an organized handbook, should be the first objective.

The executive secretary reorganized the outline according to instructions, wrote some sample sections, and set out to look for potential contributors. This was discouraging. Many of the best men were either in the Pacific or so engaged in war work that they had little time or interest. Others were frankly dubious about the value of a "guide," if its usefulness were measured against the time and energy necessary to produce it. On the other hand, everyone realized that a satisfactory "handbook" required years of preparation, considerable financial resources, and more extensive personnel than was then available. The problems of publication could not be avoided. Would it be one volume or one hundred? Would all sections have to be completed before any were published? Where was the money? The Board suggested that finished sections might be published in the scientific journals, and reprints obtained for final assemblage.

The executive secretary kept in touch with such organizations as the Committee on Asiatic Geography, and the East Indies Institute, hoping not only to coordinate all activities, but likewise to obtain in some fashion a finished section or chapter which could be used as a model and an incentive for others.

At the end of 6 months Dr. Barnett reported the status of his frustrations to the Board. His committee members had either been scattered by war duties or had become too occupied to think about the project between meetings. The potential contributors were confused or indifferent. The Board tried once again to salvage the project. It proposed that the survey be divided up. The Board and the Smithsonian would work on an anthropological guide for Oceania under the supervision of Dr. Barnett, who would become a member of the committee rather than its executive secretary. The fields of biology, geology, and geography would be assigned to various interested groups. Unfortunately Dr. Barnett could not be persuaded to continue under the circumstances then prevailing.

The Board was still willing, however, to consider the allotment of limited supporting funds, although it decided not to reassume responsibility for the project as a whole. Actually certain funds were allotted in late 1945. The committee continues to struggle, virtually independent of the Board, and some work on the earth and biological sciences has been advanced. On the whole, however, the project is dormant.

The fate of the Pacific Survey Project can be attributed to wartime conditions, lack of personnel, and above all to the difficulty of definition. The sincerity and energy of the executive secretary cannot be questioned, and the Board, too, contributed considerable time and thought to the project. Still the fact remains that neither the Board nor the committee was able to define the problem with sufficient clarity to guide the formulation of an outline. With adequate definition and outline, progress might have been possible for those sections for which competent personnel was still available. Certainly a project as potentially valuable as this one should not be abandoned, but should be so reorganized that the new knowledge and experience resulting from the war can be properly recorded. This conviction has motivated the Board to assign Dr. Barnett to the Pacific section of the War Document Survey.

Area (and Language) Notes

In the description of one of the major projects, the Survey of Area Studies in American Universities, it was pointed out that the original concept was one of service for the teachers of the area courses. The survey was completed as a factual appraisal of the programs themselves. It is the service aspect, initiated and then dropped, that is here discussed as a dead end.

Everyone who witnessed the inauguration of the foreign-area training programs in the universities shudders at the painful recollection. The Army and Navy were uncertain of what they wanted, and the universities, instead of uniting and agreeing on a sound program and an intelligent distribution of courses among themselves, competed eagerly for the chance to replace their diminishing student bodies with Government-financed trainees. Colleges of no great distinction suddenly blossomed forth with heretofore unknown experts on Central China and Timbuktu. The larger universities modestly claimed competence on any area of the world, given 24 hours' notice and the prospect of a reasonable number of tuitions paid in advance.

All this was on the administrative level of the business managers. Underneath were the harassed faculty members who had to make good these claims. English professors who had summered in Italy found themselves listed as regional specialists. Those who had cruised through the Pacific rushed to the libraries to refresh their knowledge. Others with solid claims as area experts, who through some great strength had resisted the rush to Washington, had seldom had the opportunity to organize regional courses in the discipline-dominated curricula.

This period of initial confusion in the area programs presented an exceptional opportunity for the Ethnogeographic Board to be of valuable service. The Ethnogeographic Board cannot be blamed for failing to assist in the organization of programs themselves, since universities, foundations, and councils had all tried without success, but it could have made a greater contribution to the integration of those programs. The Board was non-Governmental and unaffiliated with any university, but still its members and staff were the academic colleagues of the teachers of the area programs. At the beginning, every teacher would have welcomed information on regional bibliography, photographs, translations, films, course outlines, teaching methods, maps, mimeographed summaries, ad infinitum. The Board was in a position to act as a clearinghouse between universities on the teaching echelon. It tried, but unfortunately too late.

On September 26, 1942, the Provost Marshal General wrote to the Director about the problem of military government and the desirability of the Ethnogeographic Board's cooperation. To quote: "Accordingly, will you be good enough to designate some person in your organization to establish and maintain liaison for that purpose with the Military Government Division of my office, which is directly in charge of the Military Government Program." The Assistant Director was so designated. Three weeks later, the Acting Chief of the Military Government Division called to discuss the problem of training specialized personnel. Likewise, the Chairman of the Board had urged a conference on the problem of area teaching in universities which the Sponsors had turned down. In other words, the Board might have had the opportunity to be in on the ground floor of the area training programs, in spite of the fact that the invitations were of a generalized nature.

By spring of 1943, when some of the programs had been started, the possibility of the Ethnogeographic Board's acting as a clearinghouse on the teaching level was first discussed. However, further consideration was postponed until the next Board meeting in September of that year. At this meeting the Director was authorized to hire an assistant for this purpose. Dr. Bacon was employed, and with the collaboration of Dr. Fenton, the survey was initiated in January 1944 as previously described.

In February 1944 a mimeographed statement called "Area (and Language) Notes" was distributed to the universities. This contained special area bibliography, both general and specific; sources of maps, not only in publications but also those prepared by individual teachers who were willing to make them available on request; evaluations of regional films, and how to obtain them; and notes on the courses being given at the different universities. Reprints of an article by Mary R. Haas, "The Linguist as a Teacher of Languages," were distributed simultaneously. The Notes are excellent and illustrate what the service might have been. However, by February 1944 most of the programs had been running for some time, and many were on repeat cycles. The teachers had their own organization and their own materials, and were no longer as interested as they had been at the beginning. Even so the Notes were undoubtedly of enough benefit to warrant their continuation. The Board had promised to issue such notes "from time to time," but no more was done about them after the resignation of Dr. Bacon. In all justice, Notes were no longer needed since the area instruction itself collapsed shortly after the first issue.

This was a missed opportunity for greater service, attributable only to the fact that the Board and the staff were caught napping.

Research

Although the Ethnogeographic Board by definition was not a research organization, it was supposed to both stimulate and make research results available to the war departments and agencies. At least, such a function was discussed at practically every Board meeting. Furthermore, various proposals of a general research nature were made to the Board, either as suggestions for useful activity or as applications for moral or financial support. These were of sufficient volume to occasion the appointment of a committee on research in September 1942. The history of that committee is easily written and is characteristic of the fate of the so-called research proposals in general. The committee was named but never convened. Carter Goodrich, in accepting the chairmanship, confessed that he was far too busy to assume active leadership but was willing if the staff would handle all routine. The committee was supposed to review proposals and make recommendations to the Board, but as it worked out no proposal got far enough even to warrant review.

The Board members felt that the staff should build up a backlog of information, consisting of carefully digested reports on current investigations, compilations on particular areas, and statements on the research needed to fill in the gaps of knowledge on ethnogeographic subjects. It was also thought that the quickly prepared reports should be followed up by sounder, more comprehensive studies. The Board members failed to point out how these would be done or who would do them. Some reports were prepared, as previously described, but all these reflect immediate demands rather than a systematic effort to anticipate needs or build up a backlog. The Director, through conferences with Army and Navy officials, obtained outlines of the types of area information desired. These outlines were obviously too comprehensive. For example, one called for organized statistical data on: Area population and its composition; Government revenues and expenditures; miles of railways, highways, telegraph lines; major agricultural crops, livestock, and forest products; and other features. Such an outline was impractical for any organization smaller than the Office of Strategic Services, but the Board might have used it as a basis for one of its own which would be adapted to the peculiar abilities of the academic scholars.

A brief description of a dozen proposals, which were considered by the Board, gives an idea of the variety, and serves as a basis for analyzing the neglect of research activities.

I. SURVEY OF NATIVE ECONOMIC AREAS IN NORTH AFRICA

Walter Cline, of the University of Minnesota and the Office of Strategic Services, asked for $1,200 for secretarial services in completing a bibliography on North Africa, and a detailed account of various typical units of population. The Board declined, partially because of its policy restricting grants of money, but likewise because it felt the study was not only too late to be of practical war service, but also that the new data being acquired would outmode the value of the work.

2. AFRICA COMMITTEE PROJECTS

The Committee on African Anthropology applied for $1,600 for completing its personnel lists, making a tribal map of Africa, and for miscellaneous expenses. The Board thought that the map project should be supported but that other sources of financial support would be more appropriate.

3. DIRECTORY OF ORGANIZATIONS IN AMERICA CONCERNED WITH OCEANIA AND SOUTHEAST ASIA

The East Indies Institute applied for $500 for the compilation of a directory. The request was first turned over to the American Council of Learned Societies but was soon returned with the comment that it seemed to be a proper undertaking for the Board. It was also pointed out that a similar directory for China had recovered its subsidy by sales to Government agencies. The Director thought that the proposed directory would be of little service to his office, since he had not had great occasion to use the analogous one on China. The following decision was reached (Minutes of the Executive Committee Meeting, April 27, 1943):

> The Executive Committee approved sponsoring the project only in case the Director is able to secure orders, paid in advance, from one or more government agencies, such as the B.E.W., the O.S.S., or the State Department.

This was a most effective dismissal, since to my knowledge the Government has never been known to pay for anything in advance.

4. THE STUDY OF MODERN CHINESE CIVILIZATION

Ralph Linton, of Columbia University, applied for financial support for compiling a bibliography on China's rural social and economic conditions and for working with local Chinese informants. The request was turned down because of the Board's policy of not making grants.

5. MAP OF INDIA

Helmuth de Terra applied for $300 for assistance in making a map of India showing the racial distribution of peoples on the eastern borders, in relationship to modern transportation. The request was turned down on policy.

6. THE ETHNOGEOGRAPHIC PROBLEMS OF THE WEST COAST OF SOUTH AMERICA

7. THE EFFECT OF THE CASTE SYSTEM IN INDIA UPON CURRENT POLITICAL PROBLEMS

At the first meeting of the Board in August 1942 three problem conferences were suggested for immediate promotion. The first, No. 6, above, was considered appropriate for the American Museum of Natural History, since members of its staff had visited practically every part of the west coast of South America from Panama to Tierra del Fuego. The second, No. 7 above, might be sponsored by the University of Chicago. The third was the Conference on Bolivian Indians, which was carried out at Yale University. Nothing more was ever done about the first two in spite of the apparent success of the one trial.

8. CHECK LIST OF JAPANESE JOURNALS

Comdr. George Peter Murdock asked the Board to compile a check list of Japanese journals with articles on Micronesia which should be abstracted for the Cross-Cultural Survey files on that area. The Board sent its regrets because no Japanese scholars were available for the job.

9. BIOLOGY OF THE JAPANESE

Paul Benedict proposed a series of research studies on the biology of the Japanese. The Board considered this to be outside of its field of activity.

10. RACE PROBLEMS

The Director proposed naming a committee of biological and social scientists to explore the broad implications of race questions, and prepare a report which would correct the current misstatements and emotional attitudes. The Board members felt that no change in emotional attitudes of the Nation would result from such a report.

11. CONFERENCE ON INSTRUCTION FOR POSTWAR ADMINISTRATION

The Chairman of the Board urged the calling of a conference of university administrators and Military Government officers to coordinate the instruction in postwar administration. The Board was not enthusiastic about jumping into a field where foundations, councils, administrators, and angels tread with care. A follow-up request was answered by night letter: "Council executives think university conference premature re postwar administration. Wish to explore farther with Army and agency. Directives here not clear . . ." Apparently the directives remained cloudy since no more was done about this. It is important to note that in spite of the term "postwar" this request was submitted in November 1942 and might have aided the Ethnogeographic Board in assisting in the area training programs.

12. TRAINING OF ASIATIC GEOGRAPHERS

The Committee on Asiatic Geography, recognizing the need for more trained personnel in this field, proposed a series of upgrading and refresher courses. Geographers with advanced degrees would take special work at Chicago, Michigan, and Syracuse on India, Japan, and China. They proposed a series of scholarships for this purpose. The Board left the execution in the committee's hands.

The research promotion of the Ethnogeographic Board remained in a dormant state in spite of various attempted awakenings. The Board did not develop a stockpile of information reports, nor did it encourage others to do this job. This neglect is recognized in every Director's report together with suggestions for changing the situation. Six main blocks to research promotion can be formulated from the Director's statements and from an analysis of the reception of the proposals outlined above.

I. PERSONNEL LIMITATIONS

The staff was too small and too occupied with what were considered more pressing duties to undertake the organization of area summaries or the supervision of projects. Various attempts were made to increase the staff for this purpose, but none proved successful for reasons already discussed under Board Organization. The Board members were not selected because of lack of other obligations, so that no one of them had time to assume responsibility for research promotion. Naming more Board members probably would not have remedied this, although increasing the number of scholars officially associated with the Board might have. Several suggestions for enlarging the number of consultants were rejected.

The use of part-time personnel was never developed by the Board, although for research reports and projects this has proved successful elsewhere. In one sense service grants of small amounts would have made many a report possible, but the Board's policy was against this.

2. FRAMEWORK LIMITATIONS

Perhaps the greatest block in building up a backlog of valuable area summaries was the lack of a suitable outline. The few presented by the Army and Navy were broad enough to tax the Encyclopedia Britannica. If all branches of the Military are taken into account, the required area information covers every topic known to man, plus a few unknowns. The Ethnogeographic Board was unable to frame an outline which would be of maximum service to the Military and still appeal to the scholars. Unable may be too strong a word since only one effort was ever made to do this. This was an outline prepared by Solon Kimball for a book on an area. The Board made no use of this although a publishing firm seized it with interest.

3. POLICY RESTRICTIONS

Several applications for small grants of money led the Board into adopting the following policy at its second meeting: (1) The Board is not a fund-raising organization for projects, but limits its participation to implementation of small group meetings and secretarial assistance; (2) The Board is not a jury to pass on the importance of projects, but is willing to look them over, determine their interest to the Board's activities, and possibly suggest sources of funds. This was not a particularly clear statement of policy. For example, at the same meeting, a discussion of the Distribution Service brought forth the policy that although the Board cannot undertake the preparation of these materials for distribution it can make small assisting grants. The distinction between "materials" and "reports" was not considered.

This policy restricting the granting of funds for useful reports was most unfortunate. (At the time, the writer was the one who clamored the loudest for its adoption.) The financial resources of the Ethnogeographic Board were insufficient to allow too many or too large grants, and certainly the Board should not have usurped the standard functions of the Councils. Still, small assisting grants, under the heading of secretarial or clerical assistance if necessary, would have enabled many reports to be prepared, and, through part-time employment, more scholars could have been made active participants.

4. EVALUATION

In spite of policy the Board was forced to evaluate the actual proposals which came before it. Some of these were not supported or encouraged because they were considered to be impractical, too vague, or not particularly valuable. Two restrictions seem excessive. One, that the proposal be of immediate war concern; two, that the proposal be of direct assistance to the Board. Neither of these limitations was imposed on requests coming from the Military or Government agencies, and both kept the Ethnogeographic Board from encouraging valuable contributions.

5. ATTITUDES

The attitudes of the Board members, the staff, the Sponsors, and the scholars all handicapped the research function of the Board. The Board members thought the staff should do the work. The staff assumed that "research" jobs should be organized and supervised by someone else, anyone else. Their job was to distribute the reports and materials effectively, and to provide information and report services. The staff was engaged in war service, defined basically by requests from the Army, Navy, and war agencies. This was both important and time-consuming so that little consideration could be given to research reports, potentially of equally as great war service as anything else, as the Kennedy and Stirling reports illustrate.

The Sponsors, too, considered the Ethnogeographic Board to be an emergency service organization, and were constantly fearful that it might get entangled in some long-term commitment. The Washington office was frequently reminded of its limited life span, and the Board members were told to restrict themselves to advising the staff, and not get involved in planning or postwar problems. Research compilations and summaries are difficult to encourage when the guillotine is constantly in view.

The scholars, in general, did not volunteer their services or materials to the Board, although many wrote to inquire about the possibility of Government jobs. Those who applied for grants might have obtained the funds elsewhere and then called on the Board for assistance in placing the reports effectively, but, although some of the projects were completed, the Directorate heard no more about them.

6. ACADEMIC RELATIONS

A final reason for the limited research activity reflects the failure to establish satisfactory relationship with the scholarly institutions. This deserves separate discussion in the following pages.

Techniques

The Board utilized a series of techniques for answering questions and for promotion. These were directed almost entirely to Washington relationships. Several other techniques were proposed and discussed but never tried out. These referred largely to establishing relations with academic institutions and scholars, and to gathering information. In other words, the techniques most closely concerned with the problem of building up a research stock pile were never advanced.

1. EXTRA-WASHINGTON PROMOTION

The Board was well aware of its deficiency in keeping in touch with research institutions and scholars. At each Board meeting new techniques were discussed which involved either more personal, direct contacts, or more indirect publicity.

The Director and his immediate staff were obviously so occupied in Washington that they could not pay visits to the universities. An additional staff member was recommended but none could be found. The Chairman was authorized both to spend more time in Washington keeping in touch with the Sponsors and their committees and to devote more time to visiting leading research centers. The Chairman, however, was already so occupied with other Washington duties that his university was wondering whether he worked for them or not. Other obligations also kept the Board members from assuming the responsibility of establishing academic contacts. Various proposals for increasing the number of consultants, organizing a committee of collaborators, or establishing formal liaison with research institutions were all tabled without being seriously considered. Research grants were denied by policy.

In fact, every proposal that involved increasing the size of the Board in any way was unfavorably received. This was due to the fear both that the organization might become too cumbersome to be effective, and that any increase might convey an impression of permanence and stability beyond the Sponsors' mandate. However justified these fears, a review of the Board's activities shows clearly that the only effective assistance from extra-Washington sources came through personal connections. Yale cooperated most effectively because of the presence of a Board member, a consultant, and a research consultant. Next in order were Columbia (the Director's employer), California (the Director's alma mater), Michigan (the Chairman's employer), and the Chicago Natural History Museum (the Director's former employer).

Some of the Board's publicity and letter requests to the area specialists established indirect contacts with the scholars of the country, but more was needed. The Director prepared a statement on the activities and needs for publication in the professional journals, but no systematic coverage was achieved, nor were follow-up accounts sent out. It was suggested that the Chairman acquaint the national scientific and educational societies with its activities prior to their annual meetings, and, if possible, suggest ethnogeographical subjects for discussion. This proved difficult because so many meetings were called off in view of travel restrictions.

At one meeting it was decided that the use of letters and questionnaires was both ineffective and unpopular. This is surprising in view of the Board's success in building a roster and gathering materials and information by circularizing the area specialists. Furthermore, the Committee on Latin American Anthropology had prepared a rather comprehensive statement on research in progress, based on answers to a circular letter. In fact, the Ethnogeographic Board had every reason to believe that, in terms of quantity at least, individuals enjoy recording their experience and publicizing their abilities.

Finally, it was suggested that the Board increase the distribution of its materials outside of Washington. However, the Board maintained its policy of distributing such materials to non-Government agencies only on request. This applied even to members of the collaborating committees. Wider distribution would certainly have been good publicity, and might have inspired other scholars to produce similar materials.

2. INTERVIEW

The interview technique is recognized as a highly specialized procedure. The Board considered the possibility of developing an organization of interviewers throughout the country who could be used by the staff and by the Military. In this way the Board might itself be responsible for interviewing, or, at least, the staff could assist the agencies in framing interview questions and in interpreting the results. All this remained in the never-never land of fine ideas. The Board furnished the names of people whom the Navy, Army, or war agency might interview, but its advice and activity stopped there.

Since interviewing is done within a specific framework, it is almost inconceivable that the Army or Navy would ever take a non-Governmental group sufficiently into its confidence to assign it the task. The only use that the Ethnogeographic Board might have made of this technique was in connection with area reports, and since other factors blocked the production of these, there was little occasion for interviewing.

3. FOREIGN SCHOLARS

Residents in this country from other lands were not only an excellent source of much information, but also were, in many cases, anxious to be of service. For many reasons Government agencies were restricted in obtaining information directly from foreigners. It was suggested that the Ethnogeographic Board might undertake the organization of this vast source of knowledge. The Board agreed but did nothing. Government agencies, including the Military, would probably have been willing to disclose the types of information needed from these foreign scholars. The Board had no obligation to determine the loyalty of these individuals, since it could easily check their scholastic qualifications and the accuracy of their information. No reasons were stated for the neglect of this service, but presumably the old issue of personnel was the main cause.

APPRAISAL

In the preceding chapters the organization, materials, techniques, and activities of the Ethnogeographic Board have been presented in some detail, and each topic has been examined both from the point of view of content and effectiveness. No résumé is required, but rather an over-all review of the accomplishments in terms of the potentialities. This is not intended to lead to any final conclusion on whether the Board was successful or unsuccessful, since obviously it was both, depending on the point of view. The Sponsors and the Foundations have no cause to worry about the return on their investment, and all those associated with the Board can justifiably point with pride to the achievement. However, an appraisal of the over-all experience is necessary, if for no other reason than to guide the next board in the next emergency.

Service Organization

The Ethnogeographic Board was established primarily as a service organization for the war emergency. The coverage was broadly defined to include all areas of the world and all resources represented by the Sponsors. In practice the definition was soon reduced so that instead of covering the world, the activities were concentrated on those areas of most immediate concern to the Military, and instead of calling on all academic resources, those most conveniently at hand were developed.

With a Washington office established and a skeleton staff assembled, the Board next had to determine what it meant by service. The mandate was conveniently vague on this, which allowed ample liberty. The general confusion and lack of orientation in Washington presented to the Board an opportunity to establish an important information center on regions and peoples. To achieve success in this, questions had to be answered satisfactorily and without great delay. The Washington staff started at once to equip itself for this function by assembling an Area Roster, bibliography files, notes on library resources, local personnel lists, and other sources of quick answers. Out of this grew an initial working definition of "service," namely, answering any question which the Army, Navy, and war agencies asked.

It was immediately apparent that information service, as well as any future contributions that the Ethnogeographic Board might consider, demanded widespread publicity of an effective kind in Washington. Promotion techniques were developed; a brochure was distributed, the Director built up his personal contacts, dinner conferences were held, liaison was officially established with the Intelligence divisions. The questions rolled in and were promptly answered by phone, mail, short reports, conferences, and rarely by more extensive projects. As the cooperating committees prepared their regional personnel lists, the Board distributed them widely, which increased its prestige and contacts. With but few exceptions, the activities of the Washington staff were focused on this question-and-answer definition of service. Some of the things which might have been exceptions are summed up in the chapter on "Dead Ends." Others, like the Strategic Bulletins of Oceania and the War Document Survey, were either prepared independently of the Board, or developed after the information service went into decline. In some cases the staff encouraged the preparation of reports like the survival articles, which, although not actually requested, were so clearly in line as to raise no doubt about their ready acceptance. The bulk of all this information service went to the Army and Navy, which was consistent with the definition, and the stated interests of the staff. Other Government agencies, although not ignored, made far less use of the facilities. However, the only effective liaison was with the Army and Navy, and their requests were given definite priority.

The service was highly successful. In spite of the pettiness of some of the questions, the superficiality of some of the reports, and the difficulty of judging the returns from the many circular letters, the

Board not only assisted in orientation but made positive contributions of facts and materials. The numerous letters of appreciation from officials of the armed services are convincing testimonials in themselves (see Appendix A for samples). The liaison officers were enthusiastic in their praise. A Military Intelligence report on eight Washington agencies and their potentialities states: "Of the agencies contacted, the Ethnogeographic Board is the most important for MID and greater use should be made of its services." In fact, everyone, who has had occasion to review this service, has agreed on its merits.

Various reasons for this success have already been mentioned in the discussion of particular topics. The service was open to all agencies, with no restrictions placed on the rank of the requester or on the validity of his question, provided it fell within the Board's wide field of competence. The members of the staff were of high caliber and familiar with area problems. Questions received rapid, carefully evaluated answers and were frequently followed up with additional information. The Board had good local sources of information, principally the Smithsonian Institution and its staff, and could theoretically tap the academic resources of the country.

In fact, the Ethnogeographic Board referred to itself as a clearinghouse between the Government and scholarly institutions. This it might well have been if it had not forgotten that a clearinghouse operates in two directions. The Board, however, received requests only from the Government and was seldom forced to seek answers from sources outside of Washington itself. Instead of a clearinghouse, the organization could be described as a loan, from the Sponsors, of the services of four to five professional anthropologists (the staff) plus a group of advisers (the Board) to the military departments.

This might seem too limited a judgment, but certainly the ideal chart which the Ethnogeographic Board included in its brochure could be simplified. Instead of feeding all agencies of Government with knowledge from the country's academic institutions, most requests came from the War and Navy Departments, and most answers, outside of those furnished by the staff itself, came from the National Research Council, the American Council of Learned Societies, and the Smithsonian in Washington, and mainly from Yale outside of that city.

The Board's pragmatic definition of service, valuable as it was at the beginning, was too limited. By the end of the first year and a half, the requests for spot information were markedly reduced. Orientation, or at least an adulterated substitute therefor, had been achieved. The wealthy, heavily staffed Government agencies caught up to the Board once they got organized. In the long run they were better equipped to answer questions, gather materials, prepare reports, translate, copy photographs, and many other things that had been part of the Board's stock-in-trade.

The information service was of great initial value but should have led to even greater contributions. As the requests dwindled, the Board declined instead of using its strong position to bring the scholarly and academic resources, which it was supposed to represent, into true effectiveness. When it came to the point of assisting the Government in the planning and formulation of projects or of promoting the activities of the scholars, the Board found itself in the embarrassing position of having nothing to sell. The sales organization, in its enthusiasm, had put on a successful promotion campaign but neglected to stir the manufacturer into producing the goods.

The first Director recognized this situation in his letter of resignation, except that he made a sharp distinction between the two functions, namely, active service to the war effort versus long-term postwar projects. The Director felt that reorganization would be necessary if activities of another nature were undertaken. The Sponsors agreed, but did not authorize the changes at so late a date. However, from the present perspective, the great need for research promotion was during the first 2 years of the Board's existence and not after its service function had ceased.

Research Promotion

The reports, materials, and projects produced or stimulated by the Ethnogeographic Board have been described and evaluated, as well as those initiated or suggested but not completed. Together with the description, some reasons for the limited activities have been included, such as personnel, framing outlines, policy, techniques, and attitudes. Limited is the best descriptive word for the research-promotion activities. Those that were undertaken were well executed and valuable. There should have been more.

The staff of the Washington office should not be saddled with all the blame. It not only had its own job to do, but its whole organization was directed toward that end. At every meeting the need for more substantial academic relations and more outside reports was brought to the attention of the Board. It was the Board itself, then, that had no function. The Directorate could have carried on with a small advisory group, such as the executive committee became. The Board might well have assumed the responsibility for research promotion. Its field of activity was not limited to Washington. Ideas were abundant, and funds were ample. However, the Board was satisfied to make suggestions to the Directorate, which were usually impractical for execution.

The Sponsors accepted this situation. Although fully informed of the activities of the Directorate and the Board, they made no suggestions or comments on the fact that the full potential of academic resources was not being tapped. Little use was made of the Board to bring the varied activities of the Sponsors' committees to the attention of the Government agencies, although the Board was admittedly in an excellent position to do this. Furthermore, the Sponsors and their organizations could have stimulated the production of many useful reports and summaries for the Board to distribute effectively. Perhaps the position of being a joint committee of three councils serves to trisect rather than triple support.

If the Ethnogeographic Board's experience is at all typical, the scholars and academic institutions are not too aware of their social responsibility. The few scholars who made use of the Board were already intimately involved in the organization. The Strategic Bulletins of Oceania, and the Cross-Cultural Survey files, both under the direction of George Peter Murdock, were given wide circulation and increased utilization through the Board. Was Dr. Murdock the only scholar in the country with valuable area materials? Could the Board have obtained more reports and materials for its purposes? The difficulties were enormous. Many scholars were in the armed services; others were busy to an extreme. Both scholars and institutions were apathetic about organizing materials on their own initiative. In spite of all this the situation was not impossible. Most of the materials which the board distributed had been prepared either before it came into existence or completely independently. If the Smithsonian Institution, the Institute of Human Relations, and the National Research Council committees had materials which the Board considered worth while, surely other institutions and academic groups in the country had the same. A well-worded letter might have revealed this.

A war situation creates confusion and overwork, but it also provides a motive for production unequaled by any crisis in peacetime. In wartime, the scholars would be apt to produce the requested report first and question its legitimacy afterward. In peacetime, the same scholars would have to be convinced of the necessity of the report and probably would be loathe to donate their services unless especially interested in the particular project. The Ethnogeographic Board had the prestige of its Sponsors and sufficient resources to allow for travel and secretarial expenses, and perhaps a modest honorarium. These advantages should have made promotion of research relatively easy.

The question of scholars having time to produce such reports is hard to answer. The Board found that those who were still in their academic settings managed to find time for something within their competence which was directly concerned with the war. Once a scholar moved to Washington it was hard to get much extra out of him, and once he got into uniform, however sedentary the assignment, it was almost impossible. Raymond Kennedy, of Yale, when asked whether others could not have produced reports like his, suggested modestly that the others might not have had as much time as he did. He was only carrying his regular university schedule, plus a series of other obligations in connection with the Pacific area and the war. Still he produced three of the best area reports within a deadline limit of 30 days.

There was a real need for a true clearinghouse, an intermediary group that could discover and adapt the extant academic materials so as to suit them to Government use, and, in reverse, present the Government requirements, both immediate and anticipated, in a framework favorable for scholarly reports.

Techniques and Materials of Future Usefulness

Most of the Board's activities were directed toward immediate usefulness, but some of the materials have a permanent value as part of the academic record, and some of the techniques would be useful in other situations.

The Area Roster is a valuable record of the area specialists of the prewar period. Obviously selection is needed, and the roster should probably be cut down to about one-tenth of its present size. The selected file would serve as a base for the recording of new area experience gained during the war. On the other hand, the mimeographed personnel lists, built up both by the cooperating committees and by the Board have probably passed the peak of their maximum usefulness already.

The Board's source bibliography files were not built up systematically, but might furnish some evaluated lists of references to basic sources and to little-known areas. A statement on the area resources of Washington libraries would also be useful. The survival library would be of assistance to any agency continuing work on this subject, although the items are by no means unique. Most of the survival articles have been published, as have some of the reports. The

Kennedy and Stirling reports might be worth publishing once they are declassified. The Cross-Cultural Survey files are only on deposit at the Board's office so that the ultimate disposition of this valuable index will be determined by others. However, with the permission of the compilers, the extra copies of the Strategic Bulletins of Oceania should be made available to scholars and libraries throughout the country.

The booklet "Survival on Land and Sea" is a contribution of lasting value. It has already served as the basis for other survival books, and, in revised form may well be continued as a standard Navy publication. The manual would also be useful to scientific and lay travelers, particularly if a special edition could be brought out, which eliminated some of the hazards-of-war items, and added further travel information. Possibly an institution like the Smithsonian or the American Museum of Natural History would be interested in preparing such an edition.

The Reports on Area Studies in American Universities are a valuable documentation of the area programs and will serve as a basis for all future discussion of this important subject. Six of these have been mimeographed, and Dr. Fenton's report, previously mentioned, will put the results of the area survey on permanent record. The files of organized notes on programs at 27 universities are also an important record for the future.

The War Document Survey is directed at the problem of disposing intelligently of the valuable materials assembled by Government agencies during the war. It should furnish a basis for future legislation on this subject. The Board commissioned an analytical history of its activities in the hope that this would be of use to scholars and administrators in future emergencies, as well as an indication of the steps that must be taken to fill in the lacunae which the experience has revealed.

Some of the Board's techniques may also be applicable in other situations. For example, the whole procedure of building an area roster could be repeated whenever necessary. The simplicity of the questionnaire and card file was an outstanding feature of the roster, made possible by knowing in advance the kind of information needed. The Board's success in circularizing requests for specific materials or information might be profitable at any time. However, greater care in selecting names would probably be needed if direct Army and Navy support were not possible, since it is still not certain that such a technique would provoke a response without the backing of the Military.

Liaison officers proved immensely helpful to the Board, and, if properly selected, they would be equally valuable in peacetime as a method of integrating committee work and Government needs. The dinner conferences will always be valuable for orientation, because even in peacetime individuals with similar interests in different agencies do not always know each other. Furthermore, such dinners are a useful promotion technique, and might well have value over and above this if properly organized around significant problems.

The problem conferences, as illustrated by the one on Bolivian Indians, have future possibilities because they can be concentrated on very specific subjects. The participants need to be selected carefully and the conference should produce a report which might or might not call for further discussion. Finally, the survey technique, although not significantly modified by the Ethnogeographic Board, will continue to produce results of widespread value.

NEXT EMERGENCY

One of the fundamental purposes in preparing a history was to answer the question: Were it again necessary, should it be done in the same way? A complete answer would amount to another appraisal of the Ethnogeographic Board but some of the major points can be summarized without too much repetition of detail. An answer also involves a consideration of the next emergency, although not in the parlor pastime sense of predicting how long it will be before the next world war. Emergencies of other types may arise which will make a board necessary or at least desirable. Future emergencies, wars or otherwise, may not demand area knowledge, in which case fundamental changes in the type of board would have to be made, but since it is futile to speculate about the type of crisis, it is here assumed that area will again be an important consideration.

Any emergency which causes a rapid increase in the size of Government and which involves the creation of new agencies will certainly produce the same confusion which Washington witnessed in the first years of this war. Individuals and agencies will doubtless appreciate the same type of orientation and quick service which the present Board offered. Far from having all area resources carefully documented and organized, the same series of simple questions will again be asked, the same need for specialized personnel will again arise.

It is reasonable, then, that a board organized in many ways along the lines of the present one will be needed. However, judging by the limitations of the present experience, the next organization should have specific and distinct functions for its board and for its Washington directorate. Some features of the two future units are sketched briefly.

Board

1. A BOARD SHOULD HAVE THE SUPPORT OF THE THREE RESEARCH COUNCILS

Each Council represents a distinct group of disciplines, so that none of the three is in a position to adopt the cross-disciplinary area approach by itself. Furthermore, a wide range of backers is necessary if for no other reason than prestige, as amply illustrated by the present Ethnogeographic Board.

2. A BOARD SHOULD BE NON-GOVERNMENTAL

The Ethnogeographic Board had a great advantage by not being attached to any Government bureau. The Foundations point out frequently that the Government should finance its own needs, but it is difficult to persuade a Government bureau to finance a project which it does not control, although it has happened. The Inter-American Training Centers for language and background instruction to Government employees working in the Latin American field were financed by the Office of the Coordinator of Inter-American Affairs although administered independently by the American Council of Learned Societies. However, irrespective of the source of funds, the operation of the Board should be totally free of Government controls.

The Ethnogeographic Board was not in competition with any other non-Government group, but it was, in many respects, competing with such Government agencies as the Office of Strategic Services. Had the Ethnogeographic Board been identified with Government this might have caused friction. As it worked out, all agencies were pleased to accept aid from a non-Governmental source to which credit was merely a matter of courtesy if it were offered at all.

Finally, if scholarly research and Government action programs are not to be kept neatly separated, it is a legitimate function of the academic institutions and their representatives to anticipate and stimulate Government needs. Often an objective outside group can see the needs far more clearly than those involved in the rush of action.

3. COOPERATING COMMITTEES ARE BETTER THAN SUBCOMMITTEES

The relationship of the Ethnogeographic Board to its affiliated committees has been described in detail. From this it seems that cooperation with independent committees is a better arrangement than subordination. Each committee affiliated with the Ethnogeographic Board had its own function and its own enthusiastic personnel, both of which tend to get lost in a subcommittee which is too dependent on the top group for all guidance and action.

4. A BOARD SHOULD HAVE A SIMPLE, INTELLIGIBLE NAME

The name "Ethnogeographic" was by no means clear to the scholars and far less so to employees of Government and the Military. Both Directors admit that the name was not too happy. It is futile to suggest names for a future board, although certainly the four-letter names so common in Washington should be avoided for non-Governmental organizations.

5. A BOARD SHOULD HAVE WELL-DEFINED FUNCTIONS

As in the case of the present Board, one of these would be to guide and advise its Washington Directorate by means of an executive or an advisory committee composed of Washington members. However, in the future the board itself should assume the responsibility for establishing relationships with sponsors, scientists, and academic institutions; should undertake a survey of the existing materials, personnel, and research programs of those institutions, and make these materials available to its Washington office; and should initiate projects to fill in significant gaps in area knowledge. Techniques of keeping in touch with the scholarly resources might involve the naming of consultants in each major institution, financing surveys, making small grants for reports, and calling problem conferences. Since the board would handle one aspect of the clearinghouse, it would naturally have to aid in the phrasing of Government requirements to meet the academic abilities, and in the translation of academic reports to serve the Government needs.

6. THE MEMBERSHIP OF THE BOARD SHOULD BE IN TERMS OF ITS FUNCTIONS

The members selected should have academic connections, awareness of the problems, and an interest in serving. A paid chairman or executive officer would be necessary, although routine work and secretarial assistance could be handled through the Directorate.

Washington Office

1. THE BOARD SHOULD MAINTAIN A WASHINGTON OFFICE AND STAFF

The basic purpose of the board is to interrelate the academic research and the Government programs. For this a Washington office is essential, even though other offices are established. The Washington office would be the fiscal administrator, keeper of records, and general executor.

2. AN INSTITUTIONAL SETTING FOR THE WASHINGTON OFFICE IS DESIRABLE

The Ethnogeographic Board was located in the Smithsonian Institution, the home of one of its Sponsors. Not only did it receive enormous cold financial support from this arrangement, but also many intangible benefits. The Smithsonian's versatile scientific and technical staff, its specialized library and collections, its tremendous prestige, were all at the Board's disposal. Gradually the Board took on the color of the Smithsonian. This identification, both mystic and real, may have hampered some of its activities, but in total the benefits received counteracted the few limitations.

3. THE WASHINGTON OFFICE SHOULD ESTABLISH LIAISON RELATIONSHIPS WITH GOVERNMENT AGENCIES

The present Board established effective liaison only with the Army and Navy, but in the future an attempt should be made to increase the coverage. This would be particularly true when the board obtained academic materials of a broad character which would be useful to many agencies.

4. THE PRINCIPAL FUNCTION OF THE WASHINGTON OFFICE SHOULD BE TO ESTABLISH RELATIONSHIPS WITH GOVERNMENT

In order to do this, the staff could follow about the same lines developed by the present Directorate: dinner conferences, distribution of materials, question-and-answer service, area rosters, information files, request reports, and the rest. These would not only continue to be of real value in themselves, but would likewise serve to pave the way for the effective placement of the materials and reports which the board would provide.

The Washington office would, as in the present case, seek to make its service rapid and effective. It would continue to prepare those immediate reports which involved its staff, local sponsors, and local sources of information. Larger projects could be sent to the board for farming out to the academic institutions. Furthermore, the office should keep the board informed on the nature of Government needs, as determined by the requests, conferences, and the like, in order to guide its selection of materials and perhaps permit the anticipation of needs.

5. THE STAFF OF THE WASHINGTON OFFICE SHOULD BE SELECTED FOR THE SERVICE FUNCTION

A director and several professionally competent assistants would be needed, as well as adequate clerical help. The organization of the present Directorate would probably be adequate. The staff members should be selected on the basis of their specific knowledge of disciplines and area and their ability to carry out the service program. Whether the staff members are loaned by some institution like the Smithsonian, or hired directly, is not of major importance (except in seeking grants from the Foundations), although the local affiliation of the present staff had some advantage. In the future the staff should represent various fields of knowledge and not consist entirely of members of one profession. The director of the Washington office should appoint such consultants, subcommittees, and other affiliates as are necessary to improve the quality of the service. At all times the advisory committee of the board should be available for immediate consultation.

COST

The present Ethnogeographic Board cost about $30,000 per year, largely for the activities of the Directorate. The future board would probably increase that annual figure by about $20,000.00. The cost would not be doubled, in spite of the assignment to the board of an executive officer's salary and funds for projects and reports, because many of the functions here assigned to the board were, in the present situation, handled by the Directorate. The cost would be increased, but the results should make this worth while. The future board, if it functioned at all in the manner postulated, would come close to being a true clearinghouse between the academic and the Government in an emergency situation.

FUTURE PROBLEMS

A review of the experience of the Ethnogeographic Board points up some very real lacunae, particularly in reference to area knowledge and personnel. The Board provided some temporary fillings in its attempt to answer requests, but it could hardly be said that these desperation measures had solved the problems. Such lacunae have been apparent to many other individuals and agencies faced with the problem of assembling adequate information on other parts of the world, vitally needed during the war, but equally necessary for future action.

AREA EXPERTS

When the Ethnogeographic Board was first started, no adequate records of area experts were available, although some of the cooperating committees, like those of the National Research Council, and the Intensive Language Program, had started to build up regional lists, and the National Roster of Scientific and Specialized Personnel contained secondary information on the area experience of many individuals. The Board at once started to assemble a practical area roster. Outside of the European field there were few recognized area experts, so the Board abandoned the idea of defining expertness and filled its roster cards with the names of any individuals who had unusual experience or extended area residence. Lists were obtained from a great variety of sources, particularly for those areas of immediate concern to the Army and Navy. The Board developed its shotgun technique of circularizing a great number of people in order to obtain information, and the technique was reasonably successful. However, this is far from a permanent solution for registration of area specialists and the organization of their knowledge.

The Area Roster does not furnish a measuring stick for determining the best- and the least-known areas. Not only was expert not defined, but the Board concentrated its efforts on the lesser-known areas. No final evaluation can be made until the lists for all regions are carefully sifted, but withal, it is clear that area experts are inadequate for almost every region. A double problem is presented by this situation. First the need for registration of the significant past, present, and future area experience of scholars and other specialists, which is more than a list of places visited. Second, the necessity of creating experts on all regions, including those which are almost totally unknown.

The registration might be handled by the National Roster if new techniques of evaluation were developed, although there is no guarantee of its continuation. Mortimer Graves, of the American Council of Learned Societies, has made an estimate of the minimum number of experts which this country needs for every major area of the world. This would serve as an initial guide for the registration and allow the emphasis to be placed on quality rather than quantity. The rosters built up by the Ethnogeographic Board and other organizations would assist in evaluating past experience, but special efforts would be needed to record the new experience. Most scholastic institutions keep some record of the experience of their personnel, but it would be harder to obtain information from Government and business.

The methods of training of new area experts lie beyond the experience of the Ethnogeographic Board. Much could be learned from the area and language programs of the universities and from some of the Government training programs like the Inter-American Training Center. However, many of these special programs have already closed, and the universities are reluctant to add variants to their standard curricula. Artificial stimulation will probably be needed to inspire the universities to undertake a job which falls entirely in their special field of education.

Area Materials

The Board did not attempt to build up extensive files but it kept constantly on the lookout for sources of information, such as bibliographies, photographs, motion pictures, maps, outlines, summaries, and the like. Their experience shows that most area materials are poorly organized, and widely scattered throughout the country. A summary statement from the staff members on the results of their search for sources would help to formulate a plan for filling in the gaps. Two Board projects have, in part, been appraisals of the existing area materials. The survey of area studies in American universities includes notes on the available teaching materials, maps, photographs, slides, mimeographed outlines, motion pictures, and other useful items. A preliminary statement on resources in the universities could be prepared from the files without great difficulty. The present War Document Survey has as its primary aim the appraisal of the area materials assembled by Government agencies during the war. It would still be necessary to cover the resources of research institutions, libraries, and the like.

A statement on the relative merits of different kinds of area materials is also needed. Presumably the war agencies and the commercial concerns can determine their own needs, so that the appraisal could be limited to those materials best adapted for area instruction.

training of experts, and scholarly analysis of regions. For this, the survey of area programs would again be helpful, but other activities of the Directorate would serve only as a basis for estimating the Army and Navy needs.

Area Reports

Any great expansion of the Board's report service was blocked because of the lack of an acceptable outline of the type of information needed. The war agencies sent in broad outlines, but these were never revised to fit the capacities and knowledge of the scholars. This problem must be defined if a stockpile of useful area reports is to be built up for the future.

This is not a simple task. Every scholar knows that factual materials must be gathered in terms of a framework, and that this varies in terms of every problem. Still, all disciplines are able to agree on certain broad categories which have proved useful in the past and presumably would continue to serve. A definition cannot be too rigid, both because these categories are constantly changing and because area involves cross-disciplinary interests.

The outline developed by the Cross-Cultural Survey for filing materials in the field of anthropology was modified to meet the area requirements for the Pacific region. An examination of this revised outline would be profitable as a basis for definition. Scholars should be able to agree on certain basic categories of area information and still leave ample leeway for the special interests of any particular discipline. The Joint Committee on Latin American Studies has set a precedent in its "Outline of Research in the Study of Contemporary Culture Patterns in Latin America" (Notes on Latin American Studies, No. 2, pp. 3-26, 1943).

A satisfactory outline is but the preliminary step. It must next be decided what kind of a summary or report is most useful. The Pacific Survey Project never got by this stumbling block, since some wanted a brief summary of sources, others wanted a 5-foot shelf of books. There have been innumerable handbooks, varying from single immense volumes like the Africa Survey to soldier's pocket guides. A review of these would not lead to a final, rigid model, but would allow an appraisal of the potential usefulness of different types of area reports.

Area Training

Although the Ethnogeographic Board itself did not actively engage in any training program, the Director was consulted about the subject, and the survey of area studies was one of its major projects. The universities and the Military reached no general agreement on the nature and content of area training before the programs started, and the future is equally vague. The problem needs special study, since it is intimately related to the whole question of how to develop area experts. More is involved than courses at universities—for example, the importance of field programs and the ever-present issue of support and employment of area experts once they are trained.

The issue of area versus discipline is also included. One group claims that an intensive language and area course may prepare a good lawyer for work in a foreign area, but the reverse, an intensive course in law, is not possible. Another group asks what kind of field work could be undertaken by a man trained exclusively in area? Disciplines face the same duality internally. Is the anthropologist who studies a tribe in New Guinea interested in the region, or in getting another sample of the cultures of the world? It is apparent that considerable thought is needed on the nature and purpose of area training.

Research versus Action

One of the major problems faced by the Ethnogeographic Board was the integration of the so-called "pure" research of the scholars, and the "applied" research of the Government action agencies. No effective solution was reached which would reconcile the two approaches. This was due in part to the failure to define the area approach, and in part to the neglect of such semisolutions as the problem conferences.

This problem will become more acute in the future if the Government is to be the principal source of research funds. Two important contributions have already been made to this question by Richard H. Heindel ("The Integration of Federal and Non-Federal Research as a War Problem," Technical Paper No. 9, National Resources Planning Board, 1942), and by the Social Science Research Council ("The Federal Government and Research," mimeographed report, 1945). Both of these studies point up the problems involved and suggest issues for further consideration. The Ethnogeographic Board's experience adds its minor contribution.

Future of the Ethnogeographic Board

Some of the broad problems and important lacunae of our area knowledge have been silhouetted. It is legitimate to question whether the Ethnogeographic Board, in its present or in a reorganized form, would be useful in the further investigation of these and similar problems. This is a purely hypothetical question, since the Sponsors on October 19, 1944, agreed that they "do not intend to continue the Ethnogeographic Board after it has performed the emergency functions for which it was created." Furthermore, a plan has been formulated for the liquidation of the Washington office within the coming year (1946), and with its departure the Board will undoubtedly expire. However, the Sponsors, in requesting the historical account of the Board, asked also for suggestions on how to organize the scholarly knowledge and meet some of the outstanding problems.

Everyone connected with the Ethnogeographic Board agrees that its present organization is not suitable for undertaking the types of activities which the immediate future demands. What the board should be like in the next emergency has already been outlined. However, postponement does not solve problems, and plans for the immediate future, that is, today, should not be lightly disregarded. There is no group primarily devoted to pursuing and integrating work on the area approach. No council or academic institution has indicated that area is one of its major interests. It is logical, then, that this history conclude with a plea for the establishment of some organization which will face the problems raised by the experience of the Ethnogeographic Board. (The Conference Board of Associated Research Councils appointed a temporary committee to explore possibilities in December 1945.)

The Ethnogeographic Board not only performed a highly valuable service to the war, but also served as a unique experiment in the integration of academic research. That it made mistakes and did not always attain its full potential is easy to point out in retrospect, difficult to see at the time. It in no way detracts from the over-all merits of the organization and its truly important accomplishments. It has been the purpose of this history to see that the contributions, and the lessons learned from the experience, are not immediately forgotten.

APPENDIX A

SAMPLES OF LETTERS OF COMMENDATION

1. The Secretary of the Navy.
2. The Secretary of War.
3. The Secretary of the Conference Board of Associated Research Councils.

AI. THE SECRETARY OF THE NAVY

COPY

Address Reply to
The Secretary of the Navy
and Refer to Initials
and No.
Serial #2218416

NAVY DEPARTMENT
Washington

24 July 1944

MY DEAR DOCTOR STRONG:

On the occasion of your retirement as Director of the Ethnogeographic Board, allow me to express my appreciation for the many and continued services that you, through your organization, have performed for the Navy Department. From its inception, the Ethnogeographic Board has supplied the Navy Department with information of the greatest value on numerous remote regions of the world and on other related and highly specialized scientific subjects. This has been a very real service. Let me thank you again for your untiring efforts in our behalf.

Very sincerely yours,
(Signed) JAMES FORRESTAL

DR. WILLIAM DUNCAN STRONG, *Director*
Ethnogeographic Board
Smithsonian Institution Building
Washington, D. C.

A2. THE SECRETARY OF WAR

COPY

WAR DEPARTMENT
Washington, D. C.

August 8, 1944

DR. WILLIAM DUNCAN STRONG,
Director, Ethnogeographic Board,
Smithsonian Institute,
Washington, D. C.

MY DEAR DOCTOR STRONG:

The Ethnogeographic Board has rendered such outstanding service to the armed forces in supplying vital information at a time when it was most needed, that I take this opportunity to express our deep appreciation of this service.

The Board has been of special aid to the War Department in making available the collective experience of thousands of scientists in little known parts of the world. This has been of great value to the War Department.

As you retire as Director of the Ethnogeographic Board and return to your normal pursuits, I wish you all measures of success in your future undertakings.

Very sincerely yours,
(Signed) ROBERT P. PATTERSON
Acting Secretary of War.

A3. THE SECRETARY OF THE CONFERENCE BOARD OF ASSOCIATED RESEARCH COUNCILS

COPY

AMERICAN COUNCIL OF LEARNED SOCIETIES
Member of the
International Union of Academies

Executive Offices
1219 Sixteenth Street, N.W.
Washington 6, D. C.

November 8, 1944

DEAR DR. STRONG:

At a meeting of the sponsors of the Ethnogeographic Board, held in Washington on October 19, 1944, I was requested to convey to you their grateful appreciation of the extraordinarily valuable services that you have rendered as Director of the Washington office.

The sponsors feel that you were successful to a degree that they had feared might not be possible in organizing and making available for public service in time of great need the scholarly and scientific resources of the country.

The enthusiasm and energy with which you have devoted yourself to the organization of the work and to its direction during the period when the services of the Board were most in demand and most urgently needed cannot be too highly estimated.

We wish to assure you of our gratitude, and of the gratitude of organized scholarship and science in this country so far as we are qualified to represent it.

Very sincerely yours,
WALDO G. LELAND
Secretary of the Conference Board
of Associated Research Councils

DR. WILLIAM DUNCAN STRONG,
Department of Anthropology,
Columbia University
New York 27, New York

APPENDIX B

SAMPLES OF PERSONNEL QUESTIONNAIRES

1. Questionnaire of the Committee on Latin American Anthropology.
2. Questionnaire of the Committee on the Anthropology of Oceania.
3. Follow-up questionnaire of the Oceania Committee.
4. Questionnaire of the Ethnogeographic Board.

BI. QUESTIONNAIRE OF THE COMMITTEE ON LATIN AMERICAN ANTHROPOLOGY

North American Anthropologists with Latin-American Interests

Key to Personnel File

1. Name Date of Birth Single (S), Married (M), Minor Dependents (-x)
2. Position and Institution (or other address) (Exact position needed in order to estimate availability).
3. Wife's training: Languages, Study of Anthropology or allied subjects, Field trips.
4. Linguistic ability in Spanish, Portuguese, Indian Languages, German, French, Italian, etc. Please rate each as follows:
   1) Native speaker
   2) Adequate
   3) Stumbling
   4) Reading only
   5) Writing
   6) None (if this is significant)
5. Anthropological interests. Try to indicate in order of dominance. Arch. (archaeology); ethn. (ethnology); ling. (linguistics); phys. (physical anthropology); comm. (community study); accul. (acculturation), etc.
6. Teaching ability. Offers courses on Latin-America.
   Rating in terms:
   A) Could be recommended for teaching post.
   B) Little or no teaching experience.
   C) Should not be recommended for teaching post.
7. Field Experience:
   Specific place, country, year, number of months, type work for each. (Please limit to Latin-American field trips. Field work in other parts of the world can be listed under 8 (Qualities) if desirable).
8. Qualities:
   Indicate by number which of the following type posts the individual could be recommended for, or by XYZ if necessary:
   1. Teacher in U. S. (Like Washington school for Army, Navy and Civil personnel. Requires no language but good knowledge of region and subject, teaching ability, sociological approach.
   2. Exchange teacher for Latin-America (such as mentioned for Mexico). Requires adequate language, acceptable personality, etc.
   3. Community study (such as already started by Doob and Rockefeller Committee). Adequate language and training in approach required.
   4. Archaeology (such as Institute of Andean Research Program). Arch. training, some diplomacy, at least stumbling language.
   5. Leading field parties of Latin-Americans. Some language and experience in handling field parties.
   6. Cultural attaché or other type of formal position in which protocol is important.
   7. "Tough" ethnology or work in difficult out-of-the-way places.

8. Native language teaching (such as Peruvian-Quechua program or Mexican program). Special training in linguistic techniques needed.
9. Museum display, organization, exchange with Latin-America. Requires some knowledge of museum display problems plus diplomacy.
10. Wide scale surveys, such as on food habits.
11. Compiler of library or archive data.
12. Latin-American lecture tour.
13. Economic or commercial planning. Requires some business training and knowledge of trends of particular country.

Add any other type post for which individual exceptionally suited.

Add XYZ for region or country.

Add special techniques, like mapping, photography, jungle travel, etc.

Add any pertinent additional information such as non-Latin-American field work, etc.

B2. QUESTIONNAIRE OF THE COMMITTEE ON THE ANTHROPOLOGY OF OCEANIA

258 Institute of Human Relations
Yale University

DEAR SIR:

The Committee on the Anthropology of Oceania of the National Research Council is assembling the names and addresses of scientists, business men, missionaries, and travelers who have had first-hand acquaintance with the islands of the Pacific and who might be able to supply agencies of the United States government with information of value. These names and addresses are compiled, classified by areas and islands, and distributed in monthly mimeographed installments to interested governmental agencies, enabling them to communicate at a moment's notice with those individuals best qualified to give them needed advice or information on matters of pressing importance.

The Committee also intends to assemble from these informants, and to collate, certain standardized data of a practical character, for submission to the same governmental agencies.

Your name has been submitted to the Committee as that of a person who might possess useful information on the Pacific. If you are willing to cooperate, will you kindly fill out and return the enclosed blank. It is probably unnecessary to point out the need is URGENT; the United States is at war in the Pacific.

Committee on the Anthropology of Oceania, Division of Psychology and Anthropology, National Research Council, Washington, D. C.

GEORGE P. MURDOCK, *Chairman*
CORA DU BOIS
FRED R. EGGAN
CLELLAN S. FORD
A. IRVING HALLOWELL
RALPH LINTON
MARGARET MEAD
R. LAURISTON SHARP

Name (surname in capitals): ....
Occupation: .... Year of birth: ....State where born: ....
Home address: ....
Business address: ....
Telephone numbers: .... (home) .... (business)

Of the various islands and island groups in the Pacific (including Australia, New Zealand, Hawaii, Philippines, Dutch East Indies, and all others) I have resided in or visited the following during the periods indicated for each, and I have photographs, motion pictures, and maps for those which I have checked:

	Island	From (mo, yr)	To (mo, yr)	Photos	Movies	Maps
1.	....	....	....	....	....	....
2.	....	....	....	....	....	....
3.	....	....	....	....	....	....

4. ....
5. ....
6. ....
7. ....
8. ....
9. ....

I am acquainted with the following languages to the extent indicated:

Name of language	Expert	Fluent speaker	Halting speaker	Reader	Writer
Dutch	....	....	....	....	....
French	....	....	....	....	....
German	....	....	....	....	....
Japanese	....	....	....	....	....
Malay	....	....	....	....	....
Motuan	....	....	....	....	....
Pidgin English	....	....	....	....	....
Tahitian	....	....	....	....	....
....	....	....	....	....	....
....	....	....	....	....	....
....	....	....	....	....	....

I would / would not (cross out one) be willing to fill out a follow-up questionnaire of two pages on islands about which government agencies would like further information.

I would / would not be willing to submit a report, be interviewed, or otherwise assist in the accumulation of information.

The following are names and addresses of reliable persons who should be able to supply first-hand information of importance on certain of the Pacific islands:

....
....
....
....
....
....
....
....

(Please return to Prof. George P. Murdock, 258 Institute of Human Relations, Yale University, New Haven, Conn.)

B3. FOLLOW-UP QUESTIONNAIRE OF THE OCEANIA COMMITTEE

CONFIDENTIAL AND URGENT

Please fill out IMMEDIATELY and return to George P. Murdock, 258 I. H. R., Yale University, New Haven, Conn. The data from these forms will be compiled by the Committee on the Anthropology of Oceania of the National Research Council and supplied to interested agencies of the United States Government. Information is especially desired on the less known islands and regions of the Pacific. Use a separate form for each specific district with which you are acquainted.

This is a report on .... in the island or archipelago of ...., where I (name: ....) resided from (mo., yr.) .... to ....

The approximate population of this district was ...... in 19.., when the largest settlement, named ...., contained .... persons. The ethnic composition of the district (approximate number or percentage) was ...... natives, ... half-castes, ... Japanese, ... Chinese, ... Indians, ... Americans and British, ... Germans and Italians, and ...... other Europeans.

Of the natives and half-castes, about ...... speak English, ... another European language (namely, ...), ... pidgin English, and .... another lingua franca (namely, ...).

Indicate by an A (if absent), R (if rare), or C (if common) the prevalence in the district of the following diseases: malaria ( ), dysentery ( ), leprosy ( ), typhoid ( ), syphilis ( ), gonorrhea ( ), ... ( ), ... ( ).

A good (preferably topographic) map of the district is available in the following published source: ....
(If you possibly can, append a sketch map, however rough, indicating the location of the important features of the terrain mentioned below. One or more rough silhouettes of the island or of important topographic features or human installations would be useful to aid in identification from the sea or air.)

There are high ( ), low ( ), no ( ) mountains, with a maximum elevation of .... feet. There are no ( ), a few ( ), extensive ( ), impassable ( ) swamps. There is ( ), is not ( ) an annual rainy season, lasting from .... to .... In the absence of roads, mechanized vehicles can ( ), cannot ( ) traverse the interior because of mountains ( ), jungle or swamps ( ), sand ( ), soft soil ( ). There are many ( ), a few ( ), no ( ) stretches of level ground usable as landing fields for aircraft without clearing ( ), with slight effort expended in clearing ( ), with considerable preparation ( ).

The district has many ( ), some ( ), no ( ) roads. They are narrow ( ), wide ( ), graded ( ), hard-surfaced ( ), ... ( ). There are many ( ), some ( ), no ( ) native trails. They are ( ), are not ( ) passable by equipped soldiers. Native guides into the interior are ( ), are not ( ) available (specify extent) .... Native porters are ( ), are not ( ) available (specify extent) .... Pack animals and vehicles (specify type) .... are ( ), are not ( ) available (specify extent) .... Other means of land transport are ....

The natives navigate the rivers ( ), the offshore waters ( ), the ocean ( ). They have many ( ), no ( ) native boats of .... type. They have .... boats of the following European types:.................... They can ( ), cannot ( ) provide transport through reefs to the shore.

The natives derive their food (specify extent in each case) .... from hunting, ... from fishing, ... from agriculture, and .... from trade. The staple native food plants are .... Surpluses are available in .... quantities at .... seasons. Stores of European food are ( ), are not ( ) available in .... quantities at .... places. Fresh water is abundant ( ), scarce ( ). The best sources are .... The natives do ( ), do not ( ) use intoxicants. Native resources in food and water could support an armed force of .... size for .... weeks at .... seasons.

The natives accept the currency of .... European nations in .... denominations. They accept native currency of .... type. They prefer .... as trade goods. They can ( ), cannot ( ) be secured for labor by means of ....

In the district there are many ( ), a few ( ), no ( ) beaches suitable for landing. They are hard ( ), rocky ( ), ... ( ). There are .... harbors. The best, namely at ...., is accessible to vessels of .... draught or size, and is .... free from reefs. There are .... piers and wharfs accommodating .... vessels.

In the district there are approximately (specify number) ...... radio receiving sets and ...... sending sets. At .... there is a radio station with masts ...... feet tall. Other important radio installations include .... At .... there are ...... modern buildings (specify type) ....

There are .... government schools at ....; ...... missionaries of .... nationality and .... denomination at ....; ...... traders of .... nationality at ....; ...... white doctors and ...... native doctors in the district. Medical supplies are ( ), are not ( ) available at .... The administrative headquarters is at .... in ( ), outside ( ) the district. The natives are policed by a force of (specify size and nationality) ....

Indicate by an H (if hostile), R (if resentful), S (if suspicious), T (if timid), C (if coöperative), or F (if friendly) the attitude of the natives toward the following: administrators ( ), traders ( ), missionaries ( ), anthropologists ( ), English ( ), Americans ( ), other whites ( ), Japanese ( ), other orientals ( ), half-castes ( ), neighboring natives ( ) .... ( ). The principal sources of friction with whites are ....

The natives are ( ), are not ( ) warlike. They fight (specify how frequently .... with (specify enemies) .... for (specify causes) .... Their native weapons are............. They are ( ), are not ( ) acquainted with modern firearms of (specify types) ...., and they possess (specific quantity) .... of such arms and .... of ammunition. They are ( ), are not ( ) familiar with dynamite. They employ (specify kind) .... poisons in warfare in (specify manner) .... They could ( ), could not ( ) be used for guerilla tactics in (specify ways) ....

Prestige is based primarily upon age ( ), wealth ( ), hereditary position ( ), war prowess ( ). .... ( ). The most important persons in a village are ...., and they may be distinguished by .... The most important persons in the district are.......... .... One should apply to .... for the use of land, to .... for the use of transport, to .... for a supply of labor. The native gesture and word for "yes" are .... and ....; those for "no" are .... and .... The native attitude toward sexual advances toward their women by whites is .... Native taboos, beliefs, sacred objects, and rules of etiquette which it is extremely important to know and respect are the following: ....
....
....
....
....

B4. QUESTIONNAIRE OF THE ETHNOGEOGRAPHIC BOARD

(*Use separate sheets for each Major Area*)

ETHNOGEOGRAPHIC BOARD

Major Area:	Name:
	Pres. Occ.:
Sub Area:	Rank:
Country or Island:	Bus. Add.:
....	Home Add.:

Bus. Phone:
Home Phone:
Place and Year of Birth: Highest Academic Degree:
Profess. Exper.:

Field Exper.:	from (mo./yr.)	to (mo./yr.)	Number Photos	Estimate Movies (feet)	Maps
Specific District					
1.	....	....	....	....	....
2.	....	....	....	....	....
3.	....	....	....	....	....
4.	....	....	....	....	....
5.	....	....	....	....	....
6.	....	....	....	....	....
7.	....	....	....	....	....
8.	....	....	....	....	....

Special subjects of study:

Ling. Abil.:	*Speak*	*Read*	*Write*
Native:			
European:			

Other useful observations:

Names and addresses of other important travelers:

Instructions: Please cooperate by filling out the accompanying questionnaire and returning it to the Ethnogeographic Board as soon as possible, stating personal experience in countries outside the United States. This information will be of service in providing the War Agencies with sources of information on areas of possible military interest.

Use separate sheets for each major area.

Major Area: Africa, Asia, Europe, Latin America, Oceania (including Australia), Far North of America (Greenland, Arctic Canada, Alaska).

Sub Area:	e.g., Polynesia and Indonesia within Oceania; South America within Latin America; Near East and Far East within Asia.
Country or Island:	Small or isolated islands or remote districts are very important and should be carefully specified.
Profess. Exper:	(Professional Experience). Here state briefly most significant stations in career.
Field Experience:	This is important with reference to specific districts and localities visited, and the recency, duration, and intensity of observation. List separately and chronologically the districts where you actually traveled.
Photos., Movies, Maps:	State approximate number of photographs or feet of movies that show terrain, coast lines, harbors, cities, towns, or other features of possible military interest.
Special Subjects of Study:	e.g., Malaria control, collecting birds, etc.
Ling. Abil.:	(Linguistic Ability): What languages, including lingua francas, current in that area, do you control in sense of speak, read, or write? If slight or full command, so state.
Other Useful Observations:	Include data outside one's specialty, of possible strategic value, such as travel conditions, native customs and attitudes, description of terrain, harbors, power installations, air fields, etc.

APPENDIX C

SAMPLES OF THE ETHNOGEOGRAPHIC BOARD'S CIRCULAR LETTER REQUESTS

1. Specific information request letter.
2. Request for photographs.
3. Army and Navy instructions.
4. Request for Baedeker's Guides.

CI. SPECIFIC INFORMATION REQUEST LETTER

COOPERATING WITH

Joint Committee on the Latin American Studies of the A.C.L.S., S.S.R.C. and N.R.C.

Committees on the Anthropology of Oceania and Africa of the N.R.C.

Smithsonian War Committee

Intensive Language Program of the A.C.L.S.

and related organizations

ETHNOGEOGRAPHIC BOARD

Under the joint sponsorship of the

AMERICAN COUNCIL OF LEARNED SOCIETIES
SOCIAL SCIENCE RESEARCH COUNCIL
NATIONAL RESEARCH COUNCIL
SMITHSONIAN INSTITUTION

Wm. Duncan Strong, Director

OFFICE
Smithsonian Institution Building
Washington, D. C.

Telephone: District-1667.

Your name appears in our world file of regional specialists. This file is available to the armed forces and the War Department has made a request for detailed information you might have concerning beaches in the areas listed below:

....

....

To be of value descriptions of beaches should contain the following details:

1. Exact location. Refer to well-known places, give exact latitude and longitude, or mark on map.
2. Length and width.
3. Degree of slope, both above and below high tide level.
4. Nature of adjacent terrain, including such features as dunes, dominating hills, cliffs, and vegetation cover.
5. Surface of beach above and below tide water; i.e., mud, sand, gravel, boulders, rock.
6. Offshore obstructions—bars, reefs, rocks.
7. Currents, tides and surf—seasonal variation, etc.
8. Roads and trails leading from beach, inland or parallel to coast; direction and destination.
9. Favorable and unfavorable conditions affecting movement of troops and machines from point of landing into back country.
10. If available, large scale maps, sketches, photographs are desired.

In case you have such detailed information on many beaches, send a report on one and list the others for which you have comparable data. If you have already submitted information of this type to military or government agencies, we would appreciate knowing which agencies. We would also appreciate knowing the names and addresses of any trustworthy individuals who might furnish such information, or who have had experience in sailing small craft in the Mediterranean.

Enclosed you will find an addressed frank for forwarding this material. Your prompt attention to this matter will be a very direct contribution to the war effort.

Thanking you in advance for your valuable assistance to the United States Army and the Ethnogeographic Board, I am

Very sincerely yours,
Wm. Duncan Strong

WDS F
Enc. frank

C2. REQUEST FOR PHOTOGRAPHS

COOPERATING WITH

JOINT COMMITTEE ON THE LATIN AMERICAN STUDIES OF THE A.C.L.S., S.S.R.C. AND N.R.C.

COMMITTEES ON THE ANTHROPOLOGY OF OCEANIA AND AFRICA OF THE N.R.C.

SMITHSONIAN WAR COMMITTEE

INTENSIVE LANGUAGE PROGRAM OF THE A.C.L.S.

AND RELATED ORGANIZATIONS

ETHNOGEOGRAPHIC BOARD

Under the joint sponsorship of the

AMERICAN COUNCIL OF LEARNED SOCIETIES
SOCIAL SCIENCE RESEARCH COUNCIL
NATIONAL RESEARCH COUNCIL
SMITHSONIAN INSTITUTION

WM. DUNCAN STRONG, Director

OFFICE
SMITHSONIAN INSTITUTION BUILDING
WASHINGTON, D. C.

TELEPHONE: DISTRICT-1667.

CONFIDENTIAL

The data which you kindly supplied one of the regional committees cooperating with the Ethnogeographic Board has been incorporated into our world file of regional specialists. This file is available to the armed forces and the Navy Department has made a request for your photographs from the areas listed below:

....

....

If you have already submitted these pictures to another government agency, do not send them but notify us which agency had them. In selecting photographs for submission, please bear in mind the following suggestions and considerations:

The kinds of pictures desired are those showing terrain, islands, coast lines and rivers; landing and harbor facilities and beaches; air fields; roads, highways, bridges, viaducts, power installations, public utilities, and oil facilities; naval and military establishments; ships and water craft; cities, towns, and villages.

Send in no pictures that are not accurately and definitely located. It is important to include all additional data such as date (year and season); time of day (if possible); direction; and any other pertinent information. Please send both prints and negatives, where available. They will be returned to you by the Navy.

The Navy requests that no movies be sent at this time. However, if you have moving pictures, kindly state the size, whether black and white, or color, the precise locality, and approximate footage.

Enclosed you will find an addressed frank for forwarding this material. Your prompt attention to this matter will be a very direct contribution to the war effort.

Thanking you in advance for your valuable assistance to the United States Navy and the Ethnogeographic Board, I am

Very sincerely yours,
WM. DUNCAN STRONG

COOPERATING WITH

JOINT COMMITTEE ON THE LATIN AMERICAN STUDIES OF THE A.C.L.S., S.S.R.C. AND N.R.C.

COMMITTEES ON THE ANTHROPOLOGY OF OCEANIA AND AFRICA OF THE N.R.C.

SMITHSONIAN WAR COMMITTEE

INTENSIVE LANGUAGE PROGRAM OF THE A.C.L.S.

AND RELATED ORGANIZATIONS

ETHNOGEOGRAPHIC BOARD

Under the joint sponsorship of the

AMERICAN COUNCIL OF LEARNED SOCIETIES
SOCIAL SCIENCE RESEARCH COUNCIL
NATIONAL RESEARCH COUNCIL
SMITHSONIAN INSTITUTION

WM. DUNCAN STRONG, Director

OFFICE
SMITHSONIAN INSTITUTION BUILDING
WASHINGTON, D. C.

TELEPHONE: DIstrict-1667.

May 24, 1943

CONFIDENTIAL

Through the courtesy of the Archaeological Institute of America, your name has been suggested to us as one who might have important data concerning the Mediterranean. Our files being available to the armed forces, the Navy Department and the War Department have requested the following materials if such are available:

(A) The Navy Department requests any photographs you may have of the northern Mediterranean and adjacent areas which fit the enclosed specifications (see enclosure part "A"). Enclosed you will find an addressed frank for forwarding such materials.

(B) The War Department requests any specific information which you might be able to furnish regarding beaches in the northern Mediterranean and adjacent areas. If you should have such specific data as are mentioned in the enclosure, part "B", please submit these directly to them. Enclosed you will find an addressed frank for your use.

Your prompt attention to these matters will be a very direct contribution to the war effort. In the event that you have no materials of the nature requested, your use of the franks to so advise the Army and the Navy would be appreciated.

Thanking you in advance for your valuable assistance to the United States Navy and Army and to the Ethnogeographic Board, I am

Very sincerely yours,
WM. DUNCAN STRONG

WDS F

Encls.: Navy frank
Army frank
Explanation sheet
Brochure

A. NAVY REQUEST:

In selecting photographs for submission, please bear in mind the following suggestions and considerations:

The kinds of pictures desired are those showing terrain, islands, coast lines and rivers; landing and harbor facilities and beaches; air fields; roads, highways, bridges, viaducts, power installations, public utilities, and oil facilites; naval and military establishments; ships and water craft; cities, towns, and villages.

If you have already submitted such pictures as are requested to another government agency, do not send them, but notify the Navy as to which agency had them. Send in no pictures that are not accurately and definitely located. It is important to include all additional data such as date (year and season); time of day (if possible); direction; and any other pertinent information. Please send both prints and negatives, where available. They will be returned to you by the Navy.

The Navy requests that no movies be sent at this time. However, if you have moving pictures, kindly state the size, whether black and white, or color, the precise locality, and approximate footage.

B. ARMY REQUEST:

To be of value descriptions of beaches should contain as many of the following details as possible:

1. Exact location. Refer to well-known places, give exact latitude and longitude, or mark on map.
2. Length and width.
3. Degree of slope, both above and below high tide level.
4. Nature of adjacent terrain, including such features as dunes, dominating hills, cliffs, and vegetation cover.
5. Surface of beach above and below tide water; i.e., mud, sand, gravel, boulders, rock.
6. Offshore obstructions—bars, reefs, rocks.
7. Currents, tides and surf—seasonal variation, etc.
8. Roads and trails leading from beach, inland or parallel to coast; direction and destination.
9. Favorable and unfavorable conditions affecting movement of troops and machines from point of landing into back country.
10. If available, large scale maps, sketches, are desired.

In case you have such detailed information on many beaches, send a report on one and list the others for which you have comparable data. If you have already submitted information of this type to military or government agencies, please notify the Army as to which agencies. The Army would also appreciate knowing the names and addresses of any trustworthy individuals who might furnish such information, or who have had experience in sailing small craft in the Mediterranean.

C4. REQUEST FOR BAEDEKER'S GUIDES

TELEPHONES:
DISTRICT 1667
NATIONAL 1810
EXTENSION 7

ETHNOGEOGRAPHIC BOARD

Under the joint sponsorship of the

AMERICAN COUNCIL OF LEARNED SOCIETIES
SOCIAL SCIENCE RESEARCH COUNCIL
NATIONAL RESEARCH COUNCIL
SMITHSONIAN INSTITUTION

HENRY B. COLLINS, JR., Director

OFFICE
SMITHSONIAN INSTITUTION
BUILDING
WASHINGTON 25, D. C.

DEAR SIR:

The Ethnogeographic Board has been requested by the American Council of Learned Societies to assist in obtaining Baedeker's guides to any parts of Germany or Austria, later than 1925, for use by American Army officers concerned with the protection of cultural treasures in Europe. As these guide books are out of print and cannot be purchased from secondhand book dealers in the quantity needed, we are seeking the cooperation of individuals who may possess copies and who would be willing to sell or donate them for the purpose indicated. The information contained in the Baedeker's is essential for the guidance of our officers who have the responsibility of salvaging and protecting artistic and historical monuments (museums, libraries, archives, works of art, and other cultural objects) in war areas.

If you have one or more Baedeker guides for Germany or Austria of a later date than 1925 that you wish to make available for this purpose, will you kindly fill out and return the enclosed form? Your cooperation will be greatly appreciated.

Thanking you in advance for your valuable assistance, I am

Very sincerely yours,
HENRY B. COLLINS, JR..

Enclosure

APPENDIX D

SAMPLES OF ARMY AND NAVY OUTLINES FOR AREA REPORTS

1. Outline submitted by the Military Intelligence Section.
2. Outline submitted by the Bureau of Medicine and Surgery, Office of the Chief of Naval Operations.

DI. OUTLINE SUBMITTED BY THE MILITARY INTELLIGENCE SECTION

General Outline

I. Topography (with map—tracings or photostats)
   a. General description (recency of sources where pertinent)
   b. Main ridges, elevations and physical divisions
   c. Beaches—detailed descriptions
   d. Interior—routes of approach, lagoons, etc.
   e. Flat areas—nature of such ground, hardness of soil, nature plant cover
   f. Vegetation and ground cover
   g. Soils (in terms of passage and transportation)

II. Ethnography
   a. Linguistic and Ethnic groups
   b. General living conditions
   c. General characteristics—reliability, training, etc.
   d. Attitudes toward United Nations and Axis
   e. Persons or relative numbers speaking English, Dutch, etc.

D2. OUTLINE SUBMITTED BY THE BUREAU OF MEDICINE AND SURGERY, OFFICE OF THE CHIEF OF NAVAL OPERATIONS

At the recent meeting of the Committee on the Anthropology of Africa, naval officers from the Bureau of Medicine and Surgery suggested some general topics relative to Africa on which the Committee might wish to devote some effort.

The Bureau of Medicine and Surgery suggests the following as a guide to desired material:

(1) Information relative to the Social, Educational and Economic levels of the various groups and areas—
- (a) Types of housing
- (b) Types of native foods
- (c) Methods of preparing foods
- (d) Habits and customs of local population—urban and rural—rituals, taboos, attitude toward strangers, etc.
- (e) Mental capacities of varying groups
- (f) Impressions as to trustworthiness and honesty.

(2) Information of special medical importance—
- (a) Local diseases and vectors
- (b) Natives names for various diseases and vectors
- (c) Native medicines used
- (d) Response to outside medical help where it has been given
- (e) Medical facilities (equipment and personnel) present

(3) Information of a geological nature—
- (a) Seasonal variations in temperature
- (b) Daily temperature variations
- (c) Rainfall, seasonal
- (d) Winds and other climatic conditions
- (e) Type of terrain—presence or absence of hills, streams, swamps, jungle, etc.

The above list of items may suggest others of a related nature. Judging by the wide response accorded the "Strategic Bulletins of Oceania," this type of presentation of material may be found desirable.

APPENDIX E

CONTRIBUTORS TO

"SURVIVAL ON LAND AND SEA"

Survival manual prepared for the Navy
by the
Ethnogeographic Board
and staff of the Smithsonian Institution

1. Paul Bartsch *Curator, Division of Mollusks* *United States National Museum*	Mollusks
2. E. A. Chapin *Curator, Division of Insects* *United States National Museum*	Insects
3. Austin H. Clark *Curator of Echinoderms* *United States National Museum*	Marine invertebrates
4. Doris M. Cochran *Assistant Curator, Division of Reptiles and Batrachians* *United States National Museum*	Sea snakes, etc.
5. Henry B. Collins, Jr. *Senior Ethnologist* *Bureau of American Ethnology*	Arctic, editing
6. Herbert G. Deignan *Associate Curator, Division of Birds* *United States National Museum*	Tropical forest, etc.
7. Herbert Friedmann *Curator, Division of Birds* *United States National Museum*	Desert
8. Harald A. Rehder *Assistant Curator* *United States National Museum*	Mollusks
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15. E. H. Walker *Assistant Curator* *Division of Plants* *United States National Museum*	Food and poisonous plants
16. Alexander Wetmore *Assistant Secretary* *Smithsonian Institution*	Water on oceanic islands

ERRATUM

On the Evolutionary Significance of the Pycnogonida, by Joel W. Hedgpeth. SMITHSONIAN MISCELLANEOUS COLLECTIONS, VOL. 106, NO. 18, MAR. 24, 1947.

Page 35, footnote 20, line 2:

"Dr. J. E. Benedict" *should read* "Dr. J. E. Hamilton."

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THE THORACIC MUSCLES OF THE COCKROACH PERIPLANETA AMERICANA (L.)

(WITH EIGHT PLATES)

BY
C. S. CARBONELL
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República Oriental del Uruguay

(PUBLICATION 3890)

CITY OF WASHINGTON
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CONTENTS

INTRODUCTION

The cockroach has been the subject of many works in entomology. Its external anatomy is well known, and the insect is commonly used for experiments in insect physiology and investigations on insecticides. However, little has been published on its internal anatomy. Considering that a better knowledge of its anatomy could be useful to physiologists, economic entomologists, and anybody who uses the cockroach for experimental work, R. E. Snodgrass, who directed this research, proposed the musculature of the thorax as a theme.

It was found, while working on this subject, that the thoracic musculature of the cockroach bears little resemblance to that of other insects. Because of these differences, and the limitation of time for the work, no comparisons have been included; the work consists chiefly of anatomical description, with an attempt at explanation of the mechanism of motion.

The author acknowledges his deep appreciation to Robert E. Snodgrass for his guidance and counsel throughout the work and for correcting the manuscript and proofs. The author further acknowledges his gratitude to the Smithsonian Institution for the facilities to do the work; and to the Institute of International Education, the Department of State of the United States, the University of Maryland, and the Ministerio de Ganadería y Agricultura de la República Oriental del Uruguay, which institutions granted the author's fellowship for graduate work at the University of Maryland, of which work this paper is a partial result. Also to Dr. E. N. Cory and Dr. E. E. Haviland, of the Department of Entomology of the University of Maryland, the author is indebted for their direction and encouragement throughout his graduate work.

I. DISCUSSION OF THE MECHANISM OF MOTION

THE CERVICAL AND VENTRAL MUSCLES

It can be observed in a living cockroach, *Periplaneta americana* (L.), that the head is capable of wide freedom of movement. The insect moves it forward or retracts it under the pronotum, or turns it to the right or left side. The head articulates on each side with the apex of the first cervical sclerites (figs. 15, 16, *1Cv*) and on such articulation swings forward and backward. The elasticity of the wide membranous areas of the neck and the folding of the first and second cervical sclerites over its articular line allows the head to make the lateral movements. The muscles responsible for the head movements can be easily seen in the dorso-ventral dissections of the thorax (figs. 17 to 20). In a general way it can be said that the muscles inserted on the tentorial bridge are retractors of the head, and the head action is aided by the muscles inserted on the ventral cervical sclerites. Of the muscles inserted on the postoccipital ridge, *52* and *53* are probably retractors too, because they insert approximately at the level of the cephalo-cervical articulations, while *56, 57,* and *58,* inserted above this level, probably swing the head on the articulations, pulling the upper part of the head backward and consequently bringing forward the lower part (mouth parts). The set of muscles moving the head does not differ much from that described by Snodgrass (II, p. 54) [1] in the Carolina grasshopper.

The whole thorax of the cockroach, though not nearly as flexible as the cervical region, has nevertheless a certain freedom of movement, which is allowed by the partial desclerotization of its sternal plates (III, p. 171). Responsible for the thoracic movement is a complicated set of ventral muscles (fig. 54) probably working together with the dorsal oblique and longitudinal muscles and a few small sterno-phragmal muscles. The function of each one of the ventral muscles is rather obscure, and a written explanation would add but little to what can be gathered by looking at the figures.

Observing the living insect, two different kinds of movement can be seen. One is an alteration of the relative position of the thoracic segments, particularly noticeable in the prothorax, which the insect moves to a certain extent on the horizontal plane. The second type of movement is observable on the ventral side of the insect. It consists in retractions of the different sclerites and alterations of their relative positions. These movements of the thorax are probably helpful to the insect when it progresses in narrow crevices.

THE FORM OF THE THORAX AND MECHANISM OF THE LEGS

The thorax of the cockroach differs in several respects from the typical pterygote insect thorax as described by Snodgrass (I). The differences are in the first place structural. The whole body of the insect is depressed, apparently as an adaptation to living in crevices, under stones, and crawling into the narrow hiding places where blattids generally live. The three thoracic segments are as flat and broad as the rest of the body, and the flat coxae, instead of extending out from them as in a grasshopper, project from the thorax backward, in a nearly horizontal position, underlapping the ventral part of the following segments. This modifies the position of the leg, which moves in a plane nearly parallel to the longitudinal axis of the body instead of perpendicular to it. When the legs are at rest, the anterior and posterior faces of the coxa, trochanter, etc., become respectively ventral and dorsal. When the animal walks, the angle formed by the coxae and the body increases slightly, more in the middle coxae than in the hind ones, and more in the front than in the middle ones. Holding the living insect upside down between the fingers, it can be seen that it is able even to move the coxae to a position perpendicular to the axis of the body, the fore coxae having much more freedom of

[1] Roman numbers in parentheses refer to literature cited at the end of the work.

movement than the other two pairs. But though these movements are possible and actually performed by the living insect, the ordinary position of the legs is lying flat against the body, and their shape indicates that they are anatomically adapted to such position.

The articulation of the coxae with the thorax is also modified according to the described conformation of the thorax. The two regular articulations, one with the pleuron and the other with the trochantin, are both located on the anterior part of the coxal rim which is almost straight between them, curving but slightly outward. The coxae do not hang from the thorax by two opposite points as a bucket from its handle, but swing like the lid of a box on its hinges. As the line on which the two articulations are located is almost parallel to a plane passing from side to side of the insect and forms a certain angle with the median line of the body, it is evident that the only kind of movements that can be made on such articulation are a promotion-adduction and its opposite, a remotion-abduction. The adduction and abduction movements are secondary here, and are due only to the angle that the line of the hinge forms with the axis of the body, the promotion and remotion components of the movement being far more important.

More free and complete adduction and abduction movements are provided by another structure. This is a membranous fold on the ventral side of the body, between the second episternal plate (figs. 16, 34, 51, *2Eps*) and the first plate of the trochantin (figs. 16, 34, 51, *1Tn*). Both plates of the episternum are fastened together by a narrow strip of membrane, and both plates of the trochantin are actually welded together. But between the second episternal plate and the first trochantinal plate there is a wide band of flexible membrane which folds, allowing the first plate of the trochantin to glide under the second plate of the episternum. When this happens, the coxa being in its normal horizontal position, a true movement of adduction takes place, the axis of the coxa being driven toward the medial line of the body. It can be observed in the living insect that the whole trochantin swings on two articular points, one being its anterior apex which fits into the V-shaped episternum, the other being the plural-coxal process. This adds freedom to the coxal movement. In the prothorax, a cut that divides the second plate of the trochantin into two pieces (fig. 16, *2Tn*) provides an additional articulation and makes the movement of the prothoracic coxa much freer than that of the mesothorax and metathorax.

The combination of the described movements allows the coxa to move in every direction. The desclerotization characteristic of Blattidae (III, p. 171) and the flexibility of the sclerites and membrane contribute to make the movement freer.

The nearly horizontal position of the coxa and leg make it also difficult to name the movements of the femur and the rest of the leg. What would be a depression of the leg if it were in a vertical plane, becomes here an almost backward movement of the leg which pushes the body forward instead of lifting it. The opposite movement brings the leg forward to its first position.

On studying the muscles responsible for the described movements, their number and complexity is amazing and it is not always possible to tell the function of a particular muscle. However, according to its origin and insertion it is possible in many cases to determine in a general way the function that a set of muscles performs. The general plan of the coxal and trochanteral muscles is almost identical in the mesothorax and metathorax, and though a little different in the prothorax, is similar enough to recognize the same scheme as in the other two thoracic segments. On account of that, the following classification has been made:

Coxal muscles.—The muscles of the coxa include promotors, remotors, adductors, and rotators.

The promotors of the coxa are: (1) Muscles that have their origin on the anterior edge of the episternum and insert on the anterior portion of the coxal rim, between the articulation with the pleural and trochantinal coxal processes. Present in mesothorax and metathorax (*126* in fig. 30; *167* in fig. 46); absent in prothorax. (2) Muscles that take their origin on the anterior edge of the episternum and under side of pleural arm and pleural ridge, and insert on a small sclerite isolated in the membrane, near the rim of the coxa and the pleurocoxal articulation. Present in the three segments (*75*, not shown in figures, *127* in fig. 31, *168* in fig. 48). (3) A muscle that originates on the tergum and inserts on the said small sclerite. Present only in the prothorax (*74* in fig. 14).

The remotors of the coxa are all the muscles inserted on the posterior part of the coxal rim and meron, which have their origins on the tergum. In the mesothorax and metathorax the powerful muscles that extend between the meron and the subalar plate work probably as remotors of the leg in addition to their function as alar muscles. In this case both the meron and the subalar plate can function as insertion and origin. A muscle that originates on the sternal arm and inserts on the posterior part of the coxal rim (present in the three segments, *83* in fig. 11, *132* in fig. 25, *172* in fig. 43) might probably act as a remotor too.

The *adductors* of the coxa are: (1) Muscles that originate on the tergum and insert on an apodemal tendon arising from the medial edge of the first plate of the trochantin, close to the coxo-trochantinal articulation. Present in the three segments. (2) Muscles that originate on the anterior edge of the first plate of the episternum (*1Eps*) and insert along the surface and the anterior edge of the first plate of the trochantin (*1Tn*). Missing in the prothorax.

The adductors of the coxa have no antagonistic set of abductor muscles, the elasticity of the sclerites being apparently the only force responsible for the abductory movements.

The *rotators* of the coxa may be supposed to include the following muscles, though it cannot be determined whether these muscles actually function as rotators or as adductors. They probably perform both movements. (1) In the prothorax, a muscle going from the mesothoracic episternum of the opposite side of the body, to the meron (*97* in fig. 54), and another muscle with the same insertion which originates on the first spina (*98* in fig. 54). (2) In the mesothorax, a muscle going from the end of the sternal arm to the ridge which limits the meron in the anterior wall of the coxa (*133* in fig. 25), and another muscle that originates on the second spina and inserts on a lower portion of the same ridge (*134* in figs. 25 and 30). (3) In the metathorax, two muscles that have their origin on different parts of the sternal arm and insert on different parts of the ridge that limits the meron on the anterior wall of the coxa. (4) In the mesothorax and metathorax, muscles going from the spina to the middle of the anterior wall of the coxa (*105* and *173* in fig. 54).

Trochanteral muscles.—The function of the trochanteral muscles is much easier to interpret than that of the coxal muscles. The trochanter has, roughly, the form of a boat, hanging from the coxa by two articulations placed on the opposite sides. From the distal side of the trochanter arises the femur. If we trace a line between the two articular points, it divides the trochanter into a proximal side and a distal (femoral) side. All the muscles inserted on the proximal side will be depressors of the leg; those on the other side, levators. Figure 53 represents the trochanter of the right hind leg, seen from the coxal side. The base of the femur can be seen on the upper part of the figure. The line *A-A'* is the articular line. *180, 181, 182* are the tendons of the levators of the leg; *177, 178, 179* those of the depressors. The tendons of the middle leg follow exactly the same arrangement (see fig. 30). The fore legs show a slight variation with only two levators instead of three.

It must be understood that levators and depressors are discussed from a morphological sense. The action of the muscles will lift or depress the leg only when its position is perpendicular to the body. Since the leg is almost parallel to the body, the levators will pull it forward and slightly up, the depressors will push it back and slightly down. This is the way that the hind legs usually work in the roach. The middle legs form a slightly greater angle with the body than the hind ones, and the front legs a still greater angle than the middle legs.

All the levators of the leg have their origin within the coxa in each of the legs. Of the three depressors, the two lateral, which are the less powerful, originate also within the coxa, on the walls and rim. The middle one (the one inserted on the proximal end of the trochanter, just opposite the femur) has branches that originate within the coxa and extracoxal branches. The extracoxal branches take their origin on the tergum, pleural ridge, and pleural arm in the prothorax, and in the same places plus sternal arm and basalar plate in the mesothorax and metathorax.

THE DORSAL AND WING MUSCLES

It is in the musculature on the wings that the cockroach thorax differs widely from the normal scheme of wing-bearing segments as given by Snodgrass (I, III). The dorsal longitudinal and oblique muscles are present but they are small and "relatively unimportant elements in the wing mechanism by comparison with those of most insects" (I, p. 177). The vertical tergosternal muscles are missing entirely, and no traces of them or substituting mechanism can be found.

Cockroaches are not powerful fliers, but they do fly. Since it is extremely difficult to analyze the mechanism of the flight by looking at the alar muscles, only an enumeration is given of the muscles related directly or indirectly to the wings, which are essentially the same in both segments of the pterothorax.

Dorsal longitudinal and oblique muscles.—These are important muscles in the flight of most insects; in the cockroach they are weak and probably not very important. The dorsal longitudinals are the weaker, the obliques being stronger. Both are found also in the prothorax, where the obliques are attached to a sclerite fastened to the lateral part of the first phragma, very close to the base of the first wing.

Muscle of the basalar plate (pronator extensor of the wing).—In both wing-bearing segments this muscle is one of the more important branches of the powerful main depressor of the leg (*135c* in fig. 27, *177c* in fig. 45). The size of this muscle seems to indicate that it plays an important role in the flight. Snodgrass (III, pp. 235 and 240) points out its role as pronator and extensor of the wing.

Muscle of the subalar plate (depressor-extensor of the wing. *128* in fig. 27, *169* in fig. 42).—Powerful muscle which originates on the meron. As in the preceding one, its size seems to indicate its importance in the flight besides its action as extensor, which has been pointed out by Snodgrass (III, p. 240). The same author (III, p. 234) shows its importance in the downstroke of the wings.

Pleuro-alar muscle (flexor of the wing. *115* in fig. 25, *158* in fig. 44).—Small muscle from the pleural ridge to the third axillary (*3Ax*, figs. 21 and 36). Its action in the wing flexion has been described by Snodgrass (III, pp. 237 to 240).

Muscles of the anterior notal wing process.—In both wing-bearing segments, a flat muscle that originates on the anterior edge of the pleural arm and pleural ridge (*116* in fig. 25, *159* in fig. 40), and inserts on the downward-bent portion of the anterior notal wing process, which articulates with the first axillary (*1Ax* in figs. 21 and 36). It is the first of a series of three muscles which ends on the posterior portion of the coxal rim, the second being between the pleural and sternal arms, the third between the latter and the coxa. Its probable action on the wing movements is difficult to explain.

II. LIST OF THE THORACIC MUSCLES

The numeral *52* has been given to the first thoracic muscle considering that 51 muscles have been found in the head. Each number in the list represents one pair of muscles located symmetrically on each side of the body.

NECK AND PROTHORAX

52. *First cervical muscle of the head* (fig. 17).—A flat, fan-shaped muscle, arising from the dorsal cervical sclerite, inserted laterally on postoccipital ridge of the head.

53. *Protergal muscle of the head* (fig. 17).—A large, flat muscle, arising from the medial line of protergum, inserted laterally on the postoccipital ridge, just below the insertion of *52*.

54. *Second cervical muscle of the head* (fig. 17).—Slender, flat muscle, arising dorsally from the cervical integument, tapering to its insertion on the tentorial bridge of the head.

55. *Longitudinal ventral muscle of the head and prothorax* (figs. 6, 17).—A medium-size, ribbon-shaped muscle, from base of the sternal arm to median part of tentorial bridge of the head.

56. Episternal muscle of the head (figs. 18, 19, 20).—Arising from the anterior external angle of episternum, inserted dorsally on postoccipital ridge of the head.

57, 58. Cephalic muscles of the cervical sclerites (figs. 19, 20).—Origins on dorsal part of postoccipital ridge, external to *56;* both extend laterally and posteriorly, *57* inserted on the first ventral cervical sclerite, *58* on the second.

59. Prothoracic longitudinal dorsal muscle (figs. 3, 18).—A flat muscle extending from the median portion of the first phragma to the integument of the neck in the point where it bends upward to join the pronotum.

60. Oblique dorsal muscle (figs. 1, 19).—Broad, flat, fan-shaped muscle. Its several bundles of fibers arise dorsally from the median part of the pronotum and converge to their insertion on a small, anvil-shaped sclerite firmly attached to the lateral portion of the first phragma, very close to the base of the fore wing.

61. Oblique dorsal muscle (figs. 1, 2, 19).—Same form as *60* but considerably smaller, lies partially underneath it, and its fibers arising from the median line of pronotum converge to their insertion on the same sclerite.

62. Transverse dorsal muscle (fig. 2).—From the medial portion of the phragma to the same insertion as *60* and *61.*

63, 64. First and second protergal muscles of the first cervical sclerite (figs. 1, 2, 3, 18).—Origins on the anterior edge of the protergum, descending vertically to insertions on the first ventral cervical sclerite. *64* is twisted around *63.*

65, 66. First and second protergal muscles of the pleural arm (figs. 2, 3, 4, 5, 6, 8, 9, 10).—From the protergum to the end of the pleural arm. Both short, small muscles arising from different parts of the protergum and converging to their insertion on the end of the pleural arm at its articulation with the sternal arm.

67. Third protergal muscle of the pleural arm (figs. 3, 5, 6, 7, 8, 9, 10, 11).—Origin on anterior edge of the protergum, goes obliquely downward and backward to the upper surface of the pleural arm.

68. Fourth protergal muscle of the pleural arm (figs. 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12).—Origin near the anterior margin of protergum, goes downward and backward to the under surface of the pleural arm.

69. Protergal muscle of the neck (figs. 3, 5, 6, 8, 19, 20).—Arises from the anterior part of the protergum and goes downward to its insertion on a fold of the ventral integument of the neck.

70. *First tergal muscle of the trochantin* (figs. 2, 3, 5, 18, 19, 20).—Arises from the tergum near the median line, goes to the anterior part of the apodemal tendon on the edge of the first plate of trochantin (figs. 15, 16, *1Tn*).

71. *Second tergal muscle of the trochantin* (figs. 2, 5, 6, 8, 20).—Arises from the tergum, near the origin of *70;* goes to the posterior part of the apodemal tendon on the edge of the first plate of trochantin (figs. 15, 16, *1Tn*).

72. *Third tergal muscle of the trochantin* (figs. 1, 2, 3, 4, 5, 6, 8, 9).—Two branches, *a* and *b,* arise from different places on the tergum but soon unite to form one muscle which inserts on first plate of the trochantin (figs. 15, 16, *1Tn*), near its posterior end.

73. *Fourth tergal muscle of the trochantin* (figs. 1, 2, 4, 5, 6, 7, 8, 20).—Arises laterally from the tergum. It is a broad, flat muscle at its origin, tapering downward to its insertion on the posterior end of the surface of trochantin.

74. *Tergal promotor of the coxa* (figs. 1, 2, 4, 6, 8, 9, 10, 11, 12, 13, 14, 18, 19, 20).—Rather broad, flat muscle, arising from the anterior edge of tergum, tapering to its insertion in small sclerite near the coxo-epimeral articulation.

75. *Sterno-pleural promotor of the coxa* (not shown in figures).—Originates on the anterior edge of episternum and under side of pleural edge; goes to the same sclerite as *74*.

76. *First tergo-meral muscle* (figs. 2, 3, 5, 6, 7).—Arises from the tergum and goes to the meron. Acts probably as a remotor of the coxa.

77. *Second tergo-meral muscle* (figs. 2, 3).—From tergum to meron. Acts probably as a remotor of the coxa.

78. *Third tergo-meral muscle* (figs. 2, 3).—Arises from tergum, internal to *76,* goes to meron. Acts probably as a remotor of the coxa.

79. *Fourth tergo-meral muscle* (figs. 1, 3).—Arises from the tergum near the median line, goes to the meron. Acts probably as a remotor of the coxa.

80. *Tergal remotor of the coxa* (figs. 2, 3, 4).—Arises from the tergum near the median line, goes to the basicosta of the coxa.

81. *Main tergal remotor of the coxa* (figs. 1, 2, 3, 4, 5, 17, 18, 19).—Powerful, flat muscle; arises from the anterior edge of the tergum, turns around most of the thoracic muscles, goes to the posterior (dorsal) portion of the basicosta of the coxa.

82. *Sternal adductor of the coxa* (figs. 5, 6).—Flat muscle arising on the sternal arm, inserted on the basicosta of the coxa.

83. Sternal muscle of the coxa (figs. 8, 9, 10, 11).—Arises on the sternal arm, goes to the basicosta of the coxa. Acts probably as a remotor.

84. Prosternal muscle of the cervical sclerite (figs. 17, 54).—A slender muscle, going horizontally from its origin on the sternal arm to the second cervical sclerite (figs. 15, 61, *2Cv*).

85. Main depressor of the leg (figs. 1 to 12).—It is the most powerful muscle in the fore leg and prothorax. From several origins on different parts of the prothorax and coxa, its branches converge to a broad apodemal tendon arising from the proximal angle of the trochanter. Its branches are:

- *a. First tergal branch* (figs. 1 to 10).—Origin on the anterior edge of the protergum.
- *b. Second tergal branch* (figs. 1 to 10).—Origin on the tergum, posterior to branch *a*.
- *c. Pleural branch* (fig. 11).—Its origin covers partly the posterior edge of the pleural arm and advances over part of the upper surface of the pleural ridge and the epimeron.
- *d. Pleural branch* (fig. 12).—Origin on the under surface of the pleural arm and pleural ridge.
- *e. First coxal branch* (fig. 8).—Origin on the medial portion of the wall of the coxa.
- *f. Second coxal branch* (figs. 8, 9).—Origin on the posterior (dorsal) wall of the coxa.
- *g. Third coxal branch* (fig. 13).—Origin on the anterior (ventral) wall of coxa and basicosta of the coxa.
- *h. Fourth coxal branch* (figs. 9, 10, 11, 12).—Arises from the medial portion of the wall of coxa.

86. Posterior depressor of the leg (fig. 7).—Origin on the posterior (dorsal) wall of coxa, goes to apodemal tendon on the trochanter.

87. Anterior depressor of the leg (figs. 13, 14).—Origin on the inner portion of the anterior (ventral) wall of the coxa, goes to apodemal tendon of trochanter.

88. Main levator of leg (figs. 7 to 14).—Two branches converge on a common apodemal tendon on the trochanter. .

- *a. Anterior branch* (figs. 7 to 14).—Arises from anterior (ventral) wall of coxa.
- *b. Posterior branch* (figs. 7 to 13).—Arises from posterior (dorsal) wall of coxa.

89. Secondary levator of the leg (fig. 7).—Small, weak muscle arising from posterior (dorsal) wall of the coxa, goes to apodemal tendon of trochanter (tendon shown in figs. 8 to 13).

Numbers *90* to *95* have been left for the muscles of the rest of the fore leg.

96. *Phragmal muscle of the sternal arm* (figs. 17, 54).—Slender muscle from the lateral portion of the first phragma to the sternal arm.

97. *Episternal muscle of the coxa* (figs. 5, 6, 54; in figs. 5 and 6 it is cut).—Flat, ribbonlike muscle, arises from the internal edge of the mesepisternum, goes to prothoracic coxa on opposite side, where it inserts on a ridge that begins at coxo-pleural articulation. Its fibers divide into two or more bundles in the midline of the body, where they cross with those of the corresponding muscle from the opposite side. Acts probably as a rotator.

98. *Spinal muscle of the coxa* (figs. 5, 6, 54; in figs. 5 and 6 it is cut).—Flat muscle, arises from first spina, inserts on the same ridge as *97*. Acts probably as a rotator.

99. *Sterno-spinal muscle* (fig. 54).—From sternal arm to first spina.

The following muscles (*100* to *106*) are intersegmental.

100. *Ventral longitudinal muscle* (fig. 54).—Extends between prothoracic and mesothoracic sternal arms.

101. *Sternal-spinal intersegmental muscle* (fig. 54).—From sternal arm of the prothorax to second spina.

102. *Ventral oblique muscle* (fig. 54).—Slender muscle, extends from prothoracic sternal arm to the edge of mesepisternum of the opposite side.

103. *Transverse ventral muscle* (fig. 54).—Broad, flat, short bundle of fibers from the first spina to the medial edge of the mesepisternum.

104. *Spino-sternal muscle* (fig. 54).—From first spina to base of mesothoracic sternal arm.

105. *Spinal rotator of the mid-coxa* (fig. 54).—Long, flat, slender muscle arising from first spina, inserted on the ridge which limits the meron of the mid-coxa.

106. *Spinal longitudinal ventral muscle* (fig. 54).—Very slender, threadlike muscle, going along the median line from the first to the second spina.

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107. *Closing muscle of the first spiracle* (fig. 35).—Small flat, triangular muscle arising from the anterior part of the chitinous ring that surrounds the spiracle, going upward to its insertion on the median part of the anterior lip.

108. First phragmal muscle of the episternum (figs. 29, 30).—Short, flat muscle inserted on the anterior edge of the episternum, slants inward to the medial part of the phragma.

109. Second phragmal muscle of the episternum (figs. 29, 30).—Much weaker than *108*. Its insertion on the episternum lies close to that of *108*, but the muscle slants outward to the lateral part of the phragma.

110. Dorsal longitudinal muscle (fig. 23).—Flat bundle of fibers that extends along the median line from first to second phragma.

111. First oblique dorsal muscle (figs. 22, 23).—Small, triangular muscle going from median portion of second phragma to median line on the tergum.

112. Second oblique dorsal muscle (fig. 22).—Broad, flat muscle going from second phragma to tergum.

113. Third oblique dorsal muscle (fig. 22).—Broad, flat muscle, going from lateral portion of the second phragma to the tergum.

114. Tergo-pleural muscle (figs. 22, 23, 24).—From the tergum, goes downward to the upper surface of pleural ridge.

115. Pleuro-alar muscle, flexor of the wing (figs. 22, 23, 24, 25).—Arises from the under side of the pleural ridge, goes dorsally to its insertion on the 3rd axillary (fig. 21, *3Ax*).

116. Tergo-pleural muscle (figs. 22, 23, 24, 25).—Broad bundle of short fibers going from a broad insertion along the anterior edge of pleural ridge and pleural arm to the downward-bent part of the anterior notal wing process which articulates with the first axillary (*1Ax* in fig. 21).

117. Pleuro-sternal muscle (fig. 25).—Broad, short muscle, from the anterior edge of the pleural arm to the anterior edge of the sternal arm.

118. First tergal muscle of the trochantin (figs. 22 to 28).—Powerful muscle, from a broad origin on the anterior edge of the tergum, goes tapering backward and downward to its insertion on the surface of the first plate of the trochantin (figs. 33, 34, *1Tn*) very close to the articulation with the coxa.

119. Second tergal muscle of the trochantin (figs. 22 to 28).—Originates on the anterior part of the tergum, inserts on apodeme on the edge of the first plate of trochantin.

120. Third tergal muscle of the trochantin (figs. 22 to 28).—Originates on the tergum posterior to *119*, goes to apodeme on the edge of the first plate of trochantin.

121. Phragmal muscle of the basisternum (figs. 28, 29).—Narrow muscle; origin on the lateral portion of the phragma; goes downward and backward to its insertion on the lateral portion of the basisternum.

122. *First episternal muscle of the trochantin* (figs. 29, 30, 31).—From its origin on the anterior edge of the episternum goes ventrally to insert on the surface of the first plate of trochantin (figs. 33, 34, *1Tn*), just before the insertion of *118*.

123. *Second episternal muscle of the trochantin* (figs. 29, 30, 31, 32).—Origin on the anterior edge of the episternum; goes ventrally to a broad insertion along the anterior edge of the first plate of the trochantin.

124. *Third episternal muscle of the trochantin* (fig. 32).—From its origin, near the anterior edge of the episternum, goes ventrally to a broad insertion on the anterior edge of the first plate of the trochantin.

125. *Phragmal muscle of the sternal arm* (fig. 54).—Origin on lateral part of the second phragma; goes inward and downward to the upper surface of basal part of sternal arm.

126. *Sternal promotor of the coxa* (figs. 28, 29, 30).—Origin on lateral part of anterior edge of episternum; goes ventrally to anterior edge of coxa, between the coxal articulations with the epimeron and trochantin.

127. *Sterno-pleural promotor of the coxa* (figs. 29, 31, 32).—Origin on surface of episternum and under surface of pleural ridge; goes tapering posteriorly to small plate near coxo-pleural articulation.

128. *Subalar muscle of the fore wing* (figs. 22 to 27).—Powerful muscle, originates on the meron of the mid-coxa, goes forward and upward to insert on the subalar plate (*Sa*). Corresponds to the depressor-extensor of the fore wing in other insects.

129. *First tergal remotor of the coxa* (figs. 22, 23, 24).—Origin on the tergum; goes dorsally to the posterior (dorsal) portion of the coxal rim.

130. *Second tergal remotor of the coxa* (figs. 22, 23, 24).—Powerful muscle, lies partially underneath *129*. Originates on the anterior part of the tergum, goes dorsally to the posterior (dorsal) portion of the coxal rim.

131. *Third tergal remotor of the coxa* (figs. 22, 23, 24).—Powerful muscle, originates on anterior median part of the tergum, goes dorsally to the posterior (dorsal) portion of the coxal rim.

132. *Sternal remotor of the coxa* (fig. 25).—Broad, flat muscle, going from the posterior edge of the sternal arm to the posterior (dorsal) portion of the coxal rim.

133. *Sternal muscle of the coxa* (fig. 25).—From the end of the sternal arm to the ridge which limits the meron on the anterior (ventral) wall of the coxa. Acts probably as a rotator.

134. *Spinal muscle of the coxa* (figs. 25, 30).—Long, flat muscle, originates on second spina, goes to the ridge which limits the meron on the anterior (ventral) wall of the coxa. Acts probably as a rotator.

135. *Main depressor of the leg* (figs. 22 to 28).—The most powerful muscle of the leg and mesothorax. Originates on several parts of mesothorax and coxa; its branches converge to a broad apodeme inserted on the proximal angle of the trochanter.

   a. Tergal branch (figs. 22 to 26).—Origin on antero-lateral part of the tergum.

   b. Sternal branch (fig. 26).—Origin on downward-bent flange of the anterior edge of the sternal arm.

   c. Basalar muscle of the fore wing (fig. 27).—This large bundle of fibers is attached anteriorly to an apodemal tendon arising from the anterior edge of the basalar plate (fig. 33, *Ba*) (edge which articulates with the edge of the episternum), inserts posteriorly on the broadest portion of the trochanteral tendon. Corresponds to the pronator-extensor of the fore wing in other insects.

   d. Coxal branch (fig. 26).—Origin on mesal part of coxal wall.

   e. Coxal branch (fig. 28). Origin on the anterior part of coxal rim, near coxo-trochantinal articulation.

136. *Posterior coxal depressor of the leg* (fig. 25).—Broad muscle which originates on the posterior (dorsal) wall of the coxa, near the rim. Its fibers converge to apodeme attached to the trochanter.

137. *Anterior coxal depressor of the leg* (figs. 27, 28, 30).—Arises from the mesal part and mesal angle of the coxa, its fibers converge on apodemal tendon attached to the proximal end of trochanter.

138. *Anterior coxal levator of the leg* (fig. 30).—Slender, weak muscle, from the anterior wall of the coxa to a thin apodemal tendon attached to the femoral part of the trochanter.

139. *Main coxal levator of the leg* (figs. 25 to 28).—With several origins on the coxal wall, its fibers converge on apodemal tendon attached to the trochanter.

   a. (figs. 25, 26).—Has its origin on the posterior wall of the coxa, toward the meral angle.

b. (figs. 27, 28).—Origin on the anterior part of the coxal rim and on the ridge which limits the meron.

c. (fig. 28).—Origin on the anterior wall of coxa and coxal rim.

140. Posterior coxal levator of the leg (fig. 25).—Rather small muscle with four branches (*a, b, c, d*) which originate on the posterior wall of the coxa. All branches converge on apodemal tendon which is attached to the trochanter very near to the tendon of *139*.

Numbers *141* to *146* have been left for the muscles of the rest of the middle leg.

METATHORAX

147. Closing muscle of the second spiracle (fig. 52).—Small, fan-shaped muscle. Origin on the inferior part of the spiracular plate. Its fibers converge on a lever arising from the inferior commissure of the spiracular opening.

148. Ventral longitudinal muscle (fig. 54).—Long, flat band of fibers going ventrally from the sternal arm of the mesothorax to the sternal arm of the metathorax.

149. Transverse ventral muscle (fig. 54).—Flat ribbon from the second spina (*2Spn*) to a small plate near the edge of the metepisternum.

150. Phragmal muscle of the episternum (fig. 54).—Broad, short, flat muscle going from the second phragma to the anterior edge of the metathoracic episternum.

151. Spino-sternal oblique muscle (fig. 54).—Flat bundle of fibers extending from the second spina to the anterior edge of the sternal arm.

152. Spino-sternal longitudinal muscle (fig. 54).—Very slender, threadlike bundle of fibers running along the medial line from the second spina to the base of the metathoracic sternal arm.

153. Dorsal longitudinal muscle (figs. 37, 38).—Flat bundle of fibers between the second phragma and the first abdominal tergum.

154. First dorsal oblique muscle (fig. 37).—Small, short muscle which originates on the median line of the tergum and goes to the medial part of the first abdominal tergum.

155. Second dorsal oblique muscle (fig. 37).—Two broad bunches of fibers (*a* and *b*) which take their origin near the median line of the tergum and go to the lateral part of the anterior edge of the first abdominal tergum.

156. Third dorsal oblique muscle (fig. 37).—Very short muscle. Origin on the tergum, insertion on an upward-bent flange on the lateral part of the edge of the first abdominal tergum.

157. Tergo-pleural muscle (figs. 37, 38, 39).—Broad, powerful muscle; origin on lateral part of the tergum, goes downward and outward to its insertion on the upper surface of the pleural ridge.

158. Pleuro-alar muscle, flexor of the wing (figs. 37 to 42, 44).—Arises from the under surface of the pleural ridge, goes upward to its insertion on the third axillary (fig. 36, *3Ax*).

159. Tergo-pleural muscle (figs. 37 to 43).—Broad, flat bundle of short fibers going from a broad origin on the anterior edge of the pleural arm to its insertion on a downward-bent part of the anterior notal wing process which articulates with the first axillary (*1Ax* in fig. 36).

160. Pleuro-sternal muscle (figs. 40 to 43).—Broad, flat, short muscle going from the anterior edge of the pleural arm to the anterior edge of the sternal arm.

161. First tergal muscle of the trochantin (figs. 37 to 46).—From a broad insertion on the anterior edge of the tergum goes tapering backward and downward to its insertion on the surface of the posterior end of the first plate of the trochantin (*1Tn* in fig. 50).

162. Second tergal muscle of the trochantin (figs. 37 to 46).—Origin on the anterior edge of the tergum, mesal of *161;* goes in the same direction as *161* to its insertion on apodemal tendon of the mesal edge of the first plate of trochantin.

163. Third tergal muscle of the trochantin (figs. 37 to 46).—Origin on anterior portion of the tergum, goes in the same direction as *162* to the same apodemal tendon.

164. First episternal muscle of the trochantin (fig. 47).—Broad, flat muscle. Origin near anterior edge of the episternum, goes ventrally to its insertion on the surface of the first plate of trochantin.

165. Second episternal muscle of the trochantin (figs. 47, 48).—Flat bundle of fibers which has its origin near the anterior edge of the episternum and goes ventrally to a broad insertion on the anterior edge of the first plate of the trochantin.

166. Third episternal muscle of the trochantin (figs. 48, 49).—Flat, short, fan-shaped muscle arising from the surface of the episternum, inserts on the anterior edge of the first plate of the trochantin, lateral of the insertion of *165*.

167. First episternal promotor of the coxa (fig. 46).—Very broad, flat muscle which originates on the anterior margin of the episternum and goes ventrally to the anterior edge of the ventral wall of the coxa, between the epimeral and trochantinal articulations.

168. Second episternal promotor of the coxa (figs. 47, 48).—Origin on the postero-lateral portion of the episternum and the under surface of the pleural ridge and pleural arm; insertion on apodemal tendon attached to a small plate near the edge of the coxa and the coxo-pleural articulation.

169. Subalar muscle of the hind wing (figs. 37 to 42).—Powerful muscle which originates on the meron and goes upward and forward to insert on the subalar plate (*Sa*). Corresponds to the depressor-extensor of the wing in other insects.

170. First sternal muscle of the coxa (figs. 40 to 43).—Slender muscle. Origin on the end of the sternal arm. Insertion on the ridge which limits the meron, very close to the coxo-pleural articulation. Probably acts on rotator or rotator-adductor of the coxa.

171. Second sternal muscle of the coxa (figs. 40, 41, 42).—Flat muscle, from a broad origin on the posterior edge of the sternal arm, goes to its insertion on the ridge which limits the meron. Probably acts as rotator or rotator-adductor of the coxa.

172. Sternal remotor of the coxa (figs. 41, 42, 43).—Broad, flat, short bundle of fibers which originates on the posterior edge of the sternal arm and inserts on the posterior (dorsal) part of the coxal rim.

173. Spinal muscle of the coxa (fig. 54).—Very slender and long bunch of fibers. Origin on the second spina. Insertion on anterior wall of the coxa, between *181b* and *181c*. Acts probably as adductor and rotator.

174. First tergal remotor of the coxa (figs. 37, 38, 39).—Flat muscle, originates on the anterior part of the tergum, goes dorsally to the posterior part of the coxal rim.

175. Second tergal remotor of the coxa (figs. 37, 38, 39).—Originates on the anterior part of the tergum, goes dorsally underneath *174* to insert on the posterior part of the coxal rim.

176. Third tergal remotor of the coxa (figs. 37, 38, 39).—Powerful muscle, originates on the anterior part of the tergum, inserts on the posterior part of the coxal rim.

177. Main depressor of the leg (figs. 37 to 46).—The most powerful muscle of the leg and metathorax. It has several origins on different parts of the metathorax and coxa, and its different branches insert on a broad common apodemal tendon attached to the proximal angle of the trochanter (*177T*).

a. *Tergal branch* (figs. 37 to 44).—Origin on anterior part of the tergum.

b. *Sternal branch* (fig. 44).—Short, flat bundle of fibers. Origin on downward-bent flange of the anterior margin of the sternal arm.

c. *Basalar muscle of the fore wing* (fig. 45).—This large bunch of fibers is attached anteriorly to an apodemal tendon arising from the edge of the basalar plate which articulates with the episternum. Corresponds to the promotor-extensor of the hind wing in other insects.

d. *First coxal branch* (figs. 41 to 45).—Origin on mesal angle of coxa.

e. *Second coxal branch* (fig. 46).—Origin on the anterior wall of the coxa and anterior part of the coxal rim.

178. *Posterior coxal depressor of the leg* (fig. 40).—Broad, flat muscle. Origin on the posterior wall of the coxa and posterior part of the coxal rim. Insertion on apodemal tendon attached to the posterior part of the proximal end of the trochanter.

179. *Anterior coxal depressor of the leg* (figs. 46, 47).— Flat muscle. Origin on anterior wall of the coxa and anterior part of the coxal rim. Insertion on apodemal tendon attached to the anterior part of the proximal end of the trochanter.

180. *Anterior coxal levator of the leg* (fig. 47).—Slender muscle, originates on the anterior wall of the coxa, inserts on apodemal tendon attached to the anterior part of the distal half of the trochanter.

181. *Main levator of the leg* (figs. 40 to 43, 46).— From three origins on the posterior and anterior walls of the coxa, its branches converge on apodemal tendon attached to the distal part of the trochanter.

a. *Posterior branch* (figs. 40, 41).—Origin on lateral angle of posterior wall of the coxa.

b. *First anterior branch* (figs. 42, 43, 46).—Has its origin on anterior part of coxal rim and ridge which limits the meron on the anterior wall of the coxa.

c. *Second anterior branch* (fig. 46).—Origin on anterior portion of coxal rim. The insertion of *173* (fig. 54) separates this branch from *b*.

182. Anterior coxal levator of the leg (fig. 40).—From different origins on the posterior wall of the coxa, its four branches converge to an apodemal tendon attached to the trochanter very closely to that of *181*.

a and *b*. (fig. 40).—Origin on posterior wall of coxa.

c and *d*. (fig. 40).—Origin on posterior part of coxal rim.

Numbers *183* to *188* have been left for the muscles of the rest of the leg.

The following muscles, going from the metathorax to the abdominal sclerites, must be considered intersegmental.

189. Spino-sternal muscle (fig. 54).—Very slender bunch of extremely long fibers going from the second spina to the second abdominal sternum.

190. Tergo-sternal muscle (figs. 38, 39).—From the upper surface of the sternal arm to the first abdominal tergum.

191. Oblique ventral muscle (fig. 54).—From the base of the sternal arm to the anterior edge of the first abdominal sternum.

192. First longitudinal ventral muscle (fig. 54).—From the under surface of the sternal arm to the anterior edge of the first abdominal sternum.

193. Second longitudinal ventral muscle (fig. 54).—Two branches having their origin on both sides of *190* converge to form a single flat muscle which goes backward overlapping *192* to insert on the anterior edge of the second abdominal sternum.

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ABBREVIATIONS USED ON THE FIGURES

For numbers of the muscles refer to part II (list of muscles).

Ax, axillaries. *1Ax*, first axillary; *2Ax*, second axillary; *3Ax*, third axillary.

Ba, basalare, basalar plate.

Bs, basisternum.

Cv, cervical plates. *1Cv*, first cervical; *2Cv*, second cervical; *3Cv*, third cervical; *4Cv*, fourth cervical.

Cx, coxa.

Epm, epimeron.

Eps, episternum. *1Eps*, first plate of the episternum; *2Eps*, second plate of the episternum.

Fm, femur.
Fs, furcasternum.
Hd, head.
Hp, humeral plate.
Ju, jugal region.
m, first median plate.
m', second median plate.
Mer, meron.
PlA, pleural arm.
PlR, pleural ridge.
SA, sternal arm.
Sa, subalare, subalar plate.
Spn, spina. *1Spn,* first spina; *2Spn,* second spina.
T, tendon (used after the number of a muscle).
Tg, tegula.
Tn, trochantin (*1 Tn,* first trochantinal plate; *2 Tn,* second trochantinal plate).
Tr, trochanter.

EXPLANATION OF PLATES

Plate 1

Fig. 1. Right half of the prothorax, dorsal view. The right half of the head can be seen in the upper part of the figure. The muscles appear as they are seen when the pronotum is removed.
2. Same. Some of the muscles which appear in the preceding figure have been removed to show the muscles underneath.
3. Same, some muscles removed.
4. Same. Right coxa, trochanter, and part of the femur are seen in the lower part of the figure. Some muscles removed.
5. Same, some muscles removed.
6. Same, some muscles removed.
7. Same, some muscles removed. Posterior wall of coxa removed to show muscles inside.
8. Same, some muscles removed in thorax and coxa.
9. Same, some muscles removed.

Plate 2

Fig. 10. Right half of the prothorax and right coxa seen from above. Some muscles removed.
11. Same, some muscles removed.
12. Same, some muscles removed.
13. Same, some muscles removed.
14. Same, some muscles removed.
15. Skeleton of the right side of the prothorax seen from above. The pronotum has been removed. Coxa, trochanter, and femur are seen in the lower part of the figure. (See explanation of abbreviations.)
16. Skeleton of the left side of the prothorax seen from below.
17. Left half of the prothorax, mesal view.

Plate 3

Fig. 18. Left half of the prothorax, mesal view. Some of the muscles which appear in figure 17 have been removed.

19. Same, some muscles removed.

20. Same, some muscles removed.

21. Articulation of the right fore wing with the mesothorax, dorsal view. Only the right half of the mesonotum and the basal part of the wing appear on the figure. (See explanation of abbreviations.)

22. Right half of the mesothorax, dorsal view. Muscles seen as they appear when the mesonotum is removed.

23. Same, some muscles removed.

24. Same, showing the coxa in the lower part of the figure. Some muscles removed.

Plate 4

Fig. 25. Right side of the mesothorax and right coxa, dorsal view. The posterior wall of the coxa has been removed to show the muscles inside.

26. Same, some muscles removed.

27. Same, some muscles removed.

28. Same, some muscles removed.

29. Same, some muscles removed.

30. Same, some muscles removed.

31. Same, some muscles removed.

32. Same, some muscles removed.

33. Skeleton of the right side of the mesothorax, dorsal view. The mesonotum has been removed. Coxa, trochanter, and femur are shown. (See explanation of abbreviations.)

Plate 5

Fig. 34. Skeleton of the left half of the mesothorax, left coxa, trochanter, and femur, ventral view. (See explanation of abbreviations.)

35. Right mesothoracic spiracle, mesal view.

36. Articulation of the right hind wing with the metathorax, dorsal view. Only the right half of the metanotum and the basal part of the wing appear in the figure. (See explanation of abbreviations.)

37. Left half of the metathorax, dorsal view. The muscles appear as they are seen when the metanotum is removed. The first abdominal tergum is shown in the lower part of the figure.

38. Same, first abdominal tergum and some muscles removed.

39. Same, some muscles removed. Coxa, trochanter, and femur shown in the lower part of the figure.

Plate 6

Fig. 40. Right half of the metathorax and right coxa, dorsal view. Posterior wall of the coxa has been removed to show the muscles inside.

41. Same, some muscles removed.

42. Same, some muscles removed.

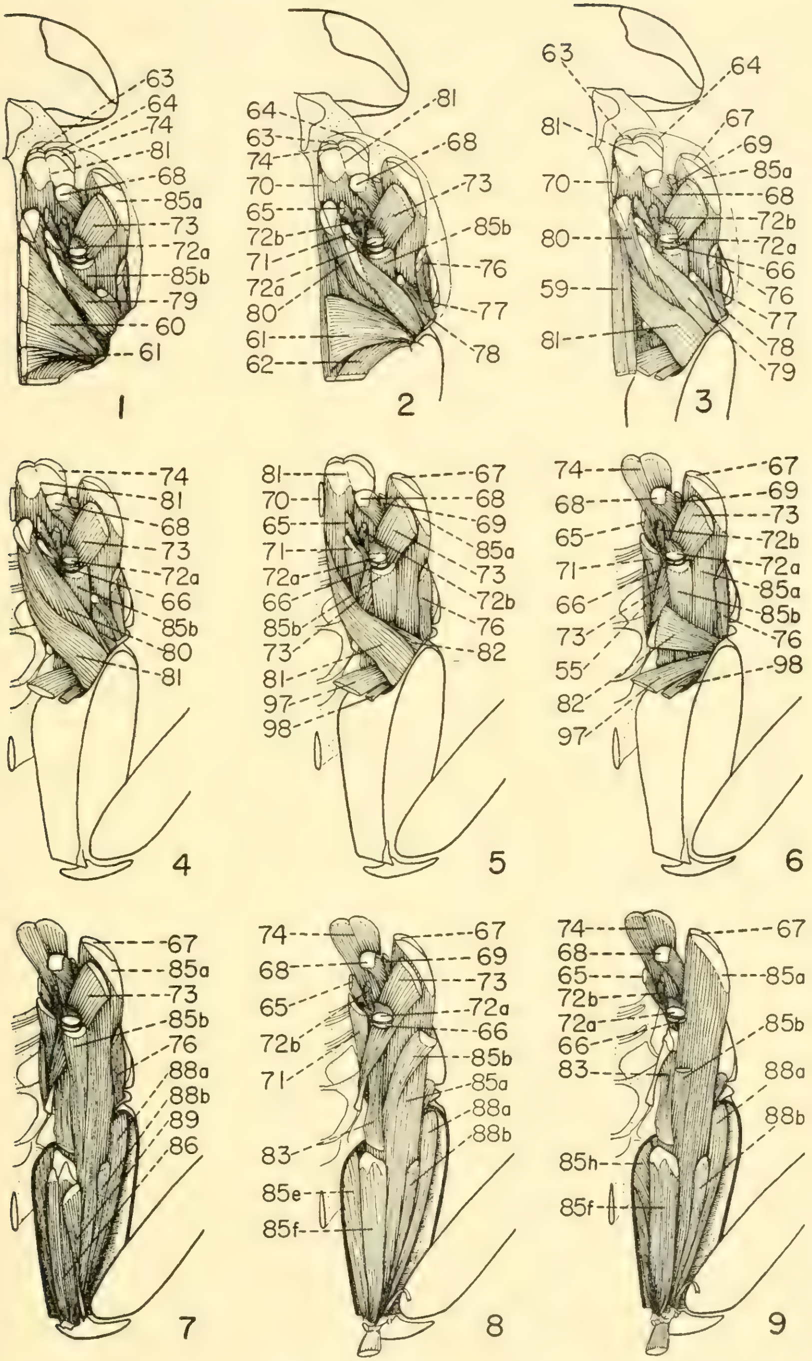
43. Same, some muscles removed.

PLATE 7

FIG. 44. Right half of the metathorax and right coxa, dorsal view. Posterior wall of coxa removed to show muscles inside. Some muscles removed.
45. Same, some muscles removed.
46. Same, some muscles removed.
47. Same, some muscles removed.

PLATE 8

FIG. 48. Right half of the metathorax, dorsal view, some muscles removed.
49. Same, some muscles removed.
50. Skeleton of the right half of metathorax, right coxa, trochanter, and femur, dorsal view. (See explanation of abbreviations.)
51. Skeleton of the left half of metathorax, left coxa, trochanter, and femur, ventral view. (See explanation of abbreviations.)
52. Right metathoracic spiracle, mesal view.
53. Trochanter of the right hind leg, dorsal view.
54. Right half of the whole thorax (nota removed), dorsal view. Only ventral muscles are shown.



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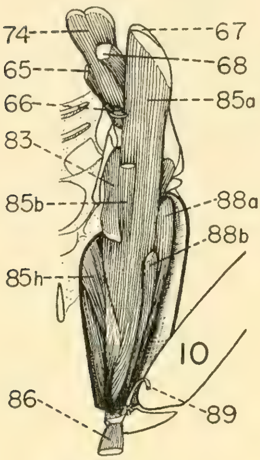

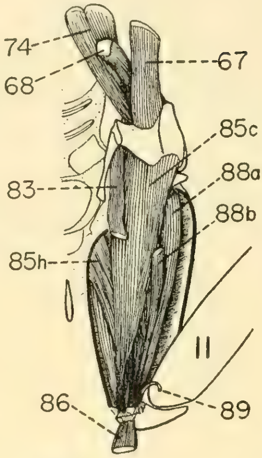

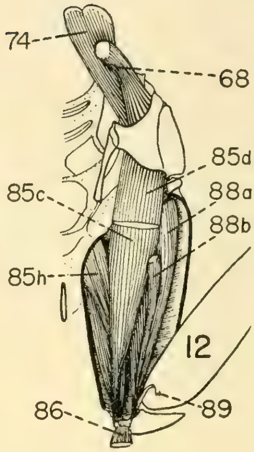

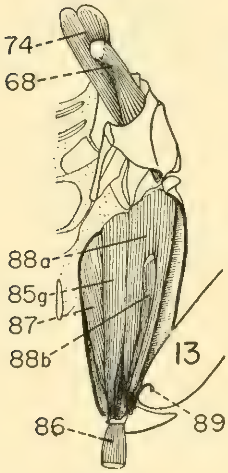

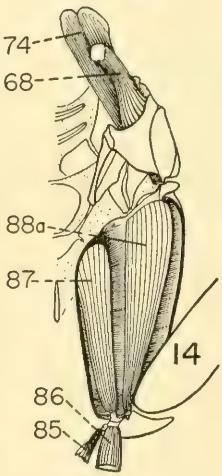

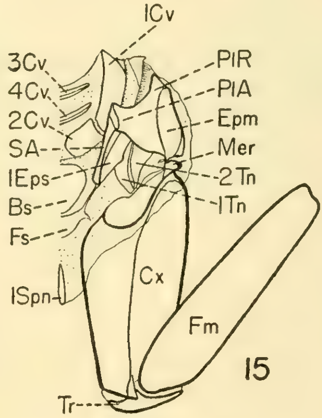

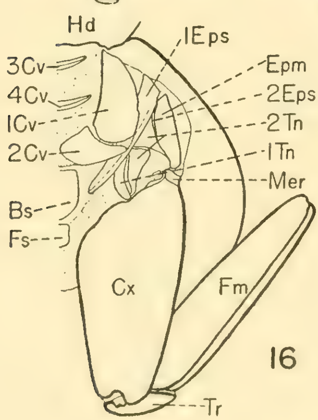

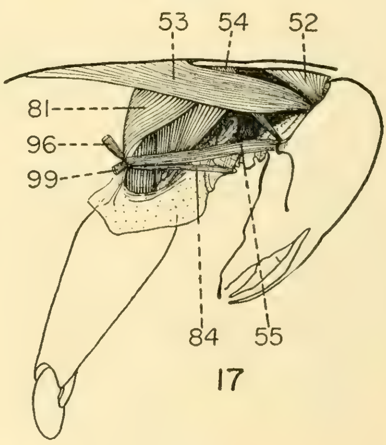

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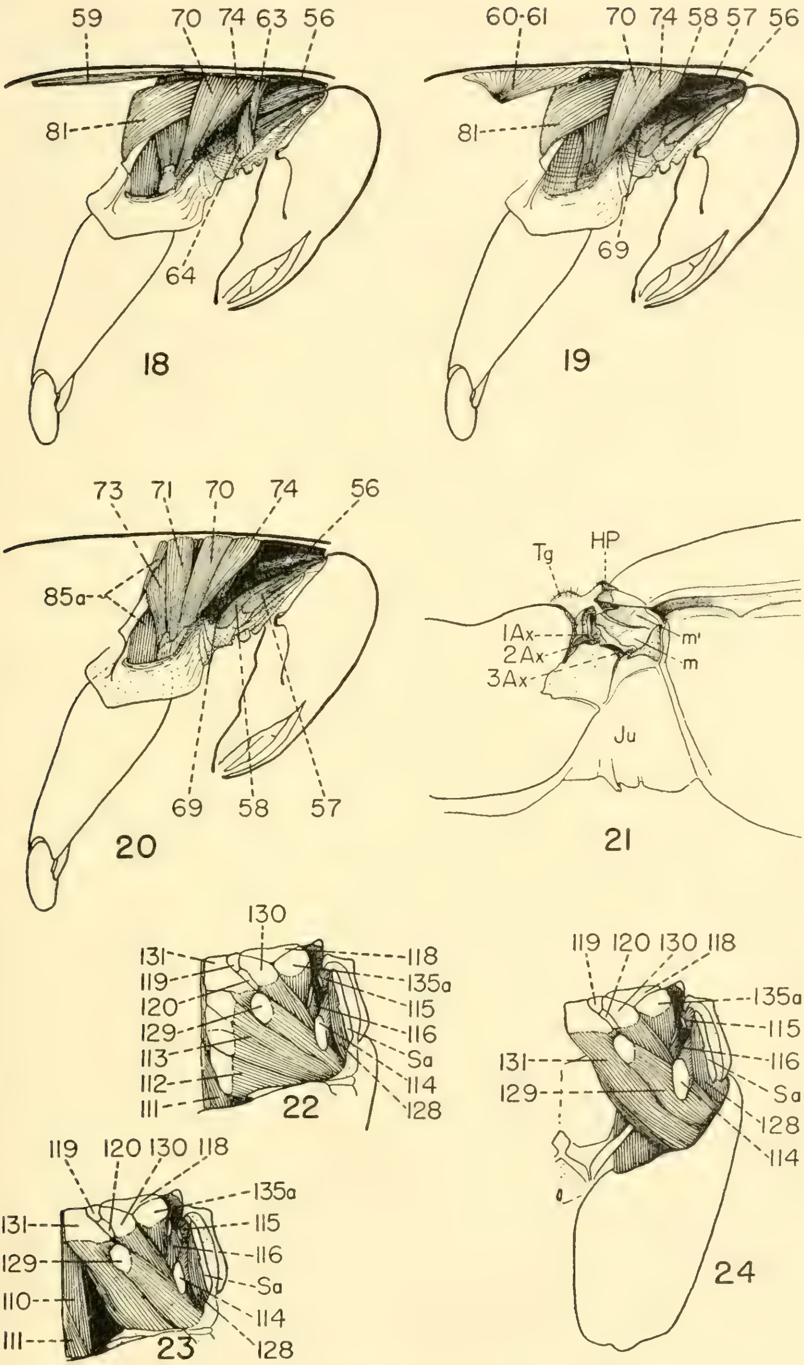

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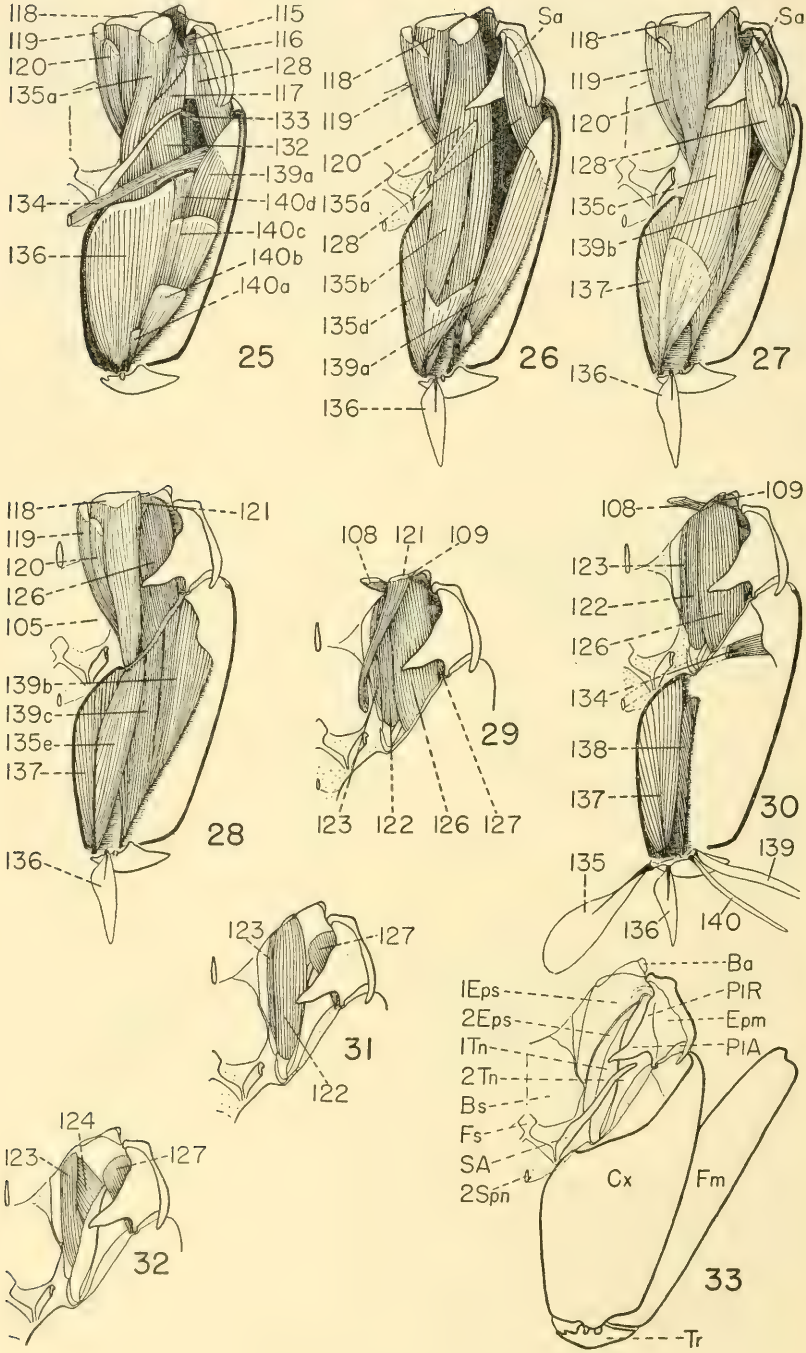

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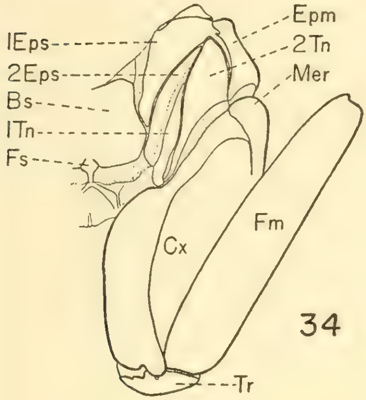

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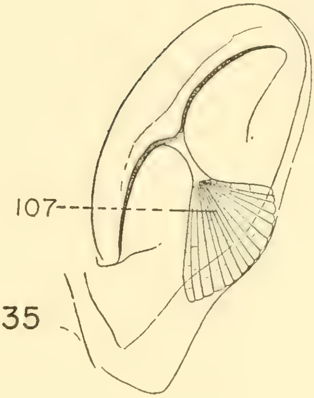

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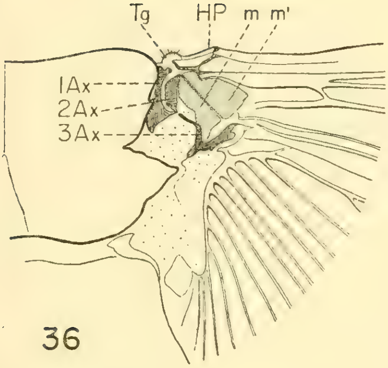

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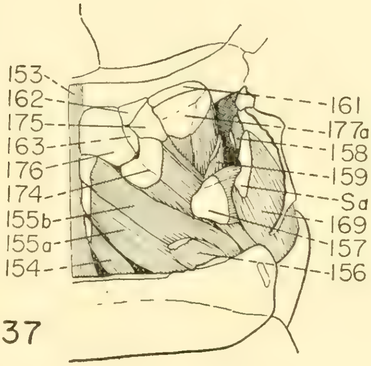

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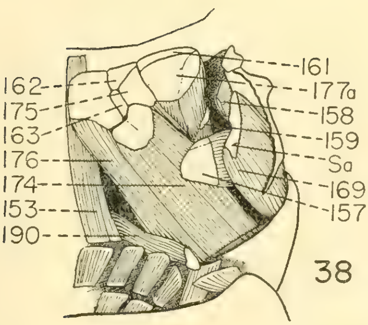

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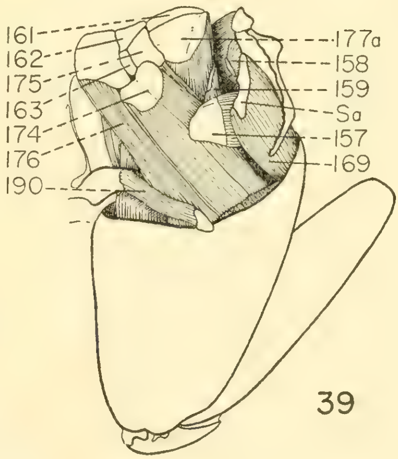

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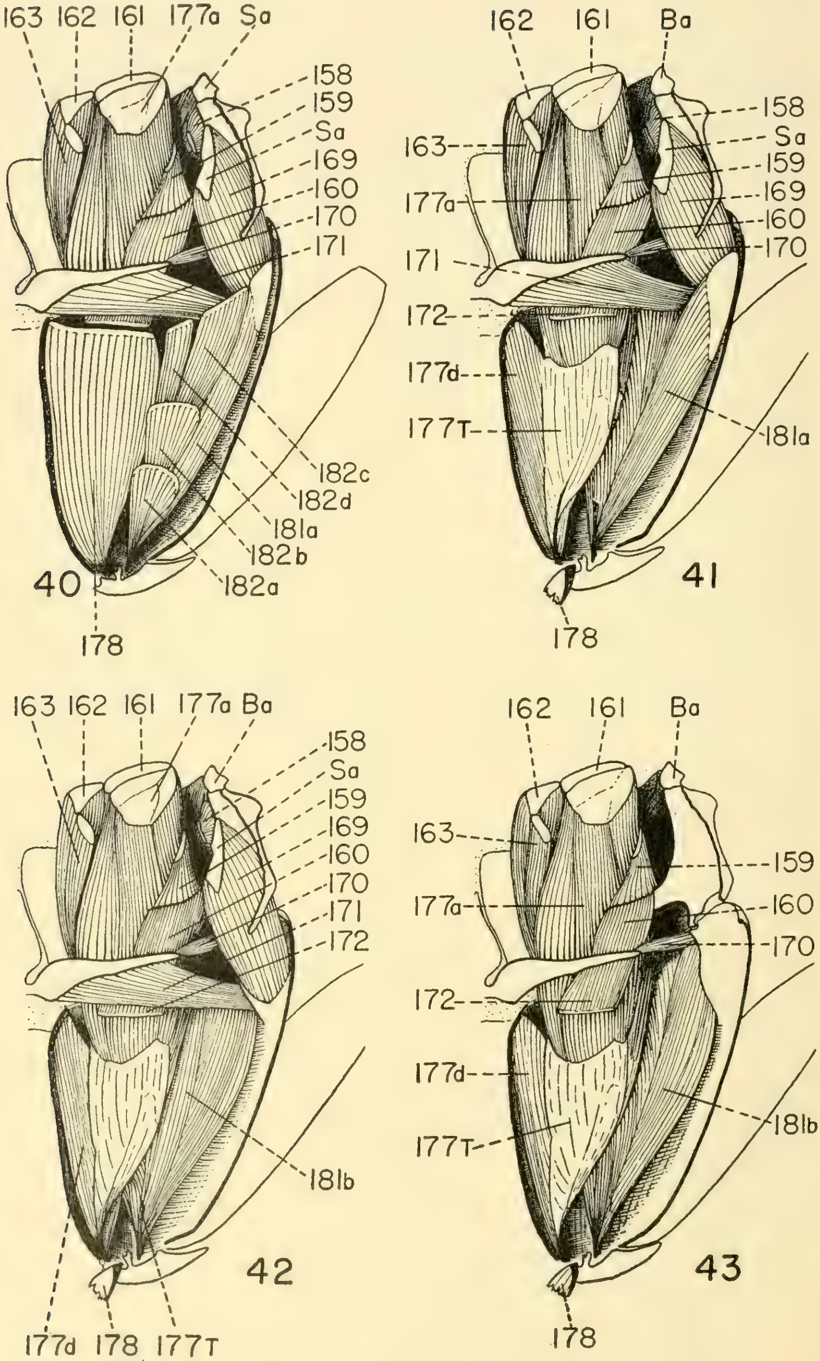
(For explanation, see p. 22.)



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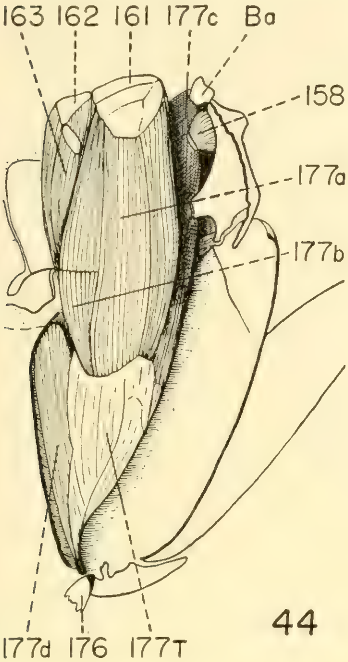

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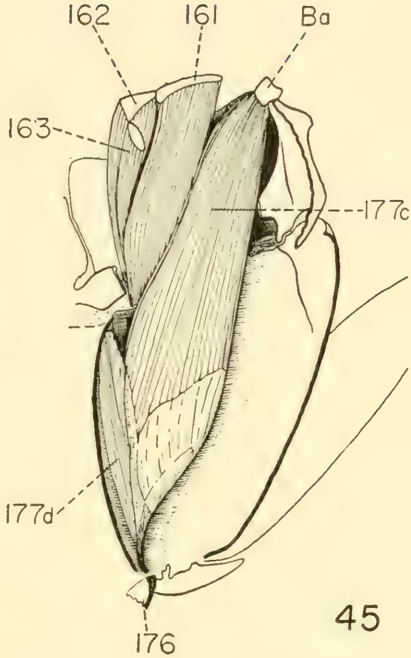

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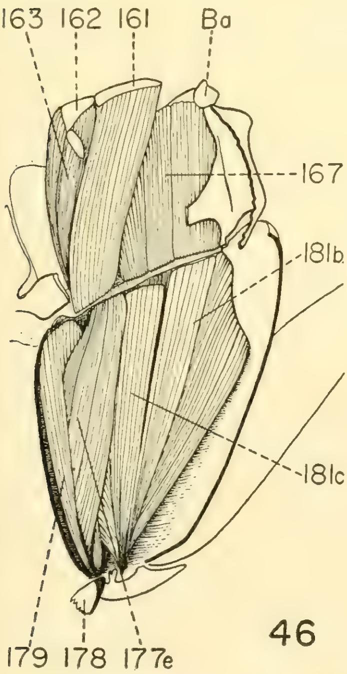

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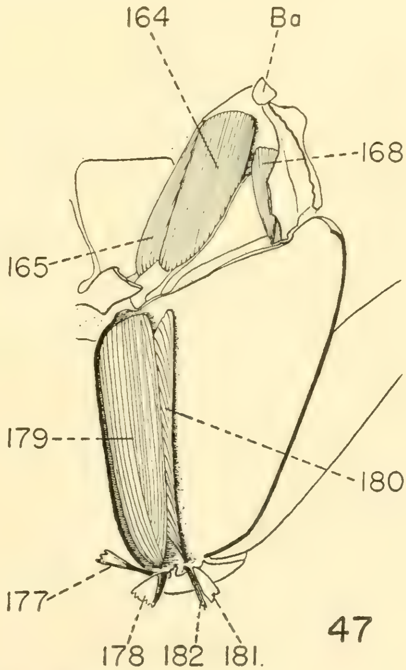

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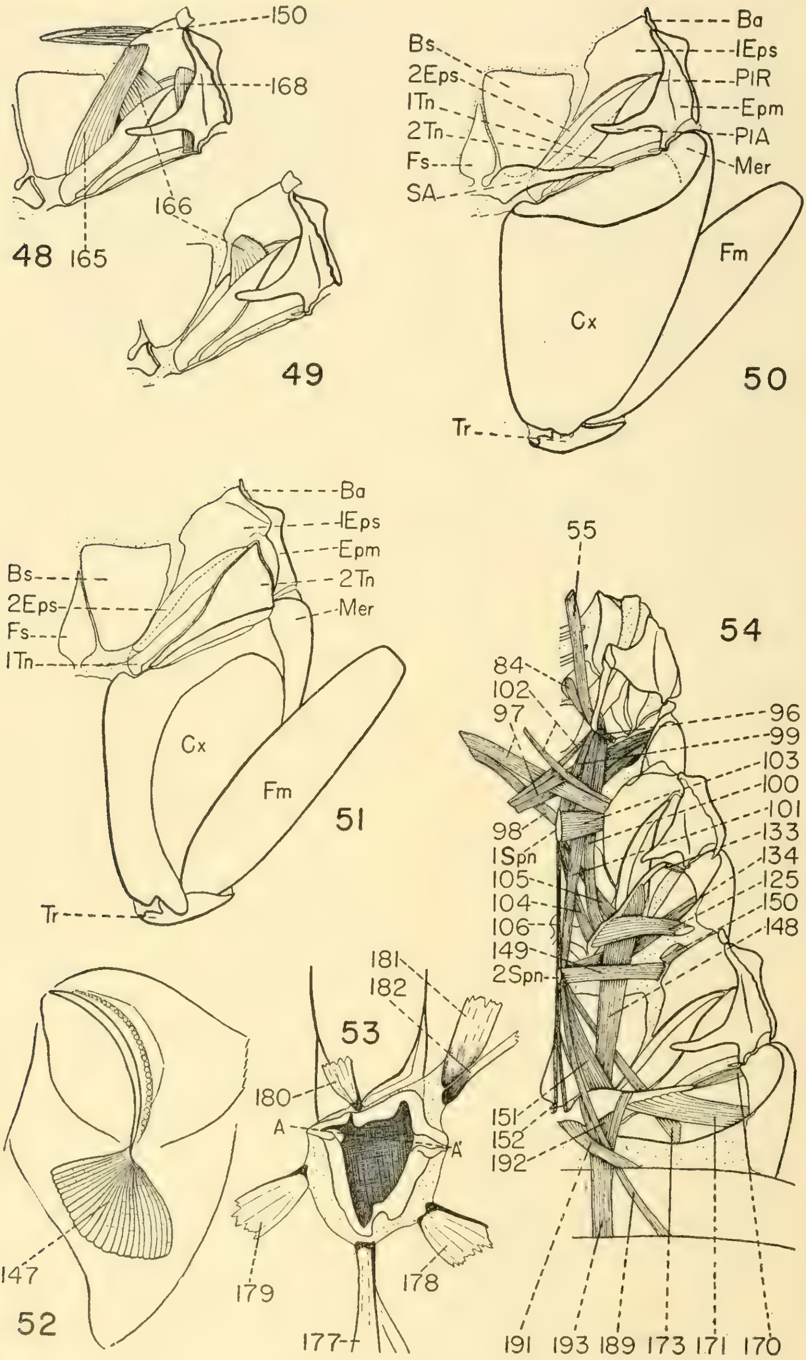
(For explanation, see p. 23.)



(For explanation, see p. 23.)

SMITHSONIAN MISCELLANEOUS COLLECTIONS
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1946-1947 REPORT ON THE 27.0074-DAY CYCLE IN WASHINGTON PRECIPITATION

BY
C. G. ABBOT
Research Associate, Smithsonian Institution

(PUBLICATION 3892)

CITY OF WASHINGTON
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In Smithsonian Miscellaneous Collections volume 104, No. 21, I reported on this cycle, and listed dates of 1946 when it was expected that greater average precipitation would occur than on other dates.

The following tabulation shows how the matter turned out. I give average precipitation per day on "preferred" and other days.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
"Preferred" ..	0.027	0.198	0.031	0.017	0.298	0.0023	0.186	0.169	0.156	0.168	0.074	0.025	0.113
Other	0.060	0.018	0.076	0.113	0.132	0.139	0.072	0.103	0.107	0.008	0.0012	0.114	0.0777
Ratio	0.45	11.0	0.41	0.15	2.26	0.016	2.58	1.64	1.46	21.	60.	0.22	1.45
Total, inches ..	1.54	2.84	1.84	1.88	6.74	2.38	3.82	4.18	3.95	2.50	1.05	2.02	34.74
Normal, inches.	3.55	3.27	3.76	3.27	3.70	4.13	4.71	4.01	3.24	2.84	2.37	3.32	42.16
Percent, normal.	44	87	49	58	182	58	81	104	122	88	44	61	82

"Preferred" days had higher average precipitation than other days in the months of February, May, July, August, September, October, and November. The contrary happened in January, March, April, June, and December. Of these unfavorable months all were exceptionally dry. But November, also very dry, turned out favorably.

For the complete year 1946, the ratio of average daily precipitations, "preferred" to other days, is 1.45. It is the thirteenth consecutive year in which this ratio has exceeded unity. The mathematical expectation for its value is 1.42.[1] The average ratio for 13 years is 1.50.

The following table gives the dates for 1947 when the average daily precipitation is expected to exceed that for all other days. In the first column are given in Roman numerals the date numbers within the 27 days of the cycle when higher average precipitation is expected. The remainder of the table gives the actual dates in the different months which correspond to these Roman numerals. These "preferred" dates should, on the average, give higher precipitation than other dates.

It should be emphasized that this prediction relates only to Washington, D. C.

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[1] See my original paper, Smithsonian Misc. Coll., vol. 104, No. 3, 1944. Also see vol. 104, No. 5, pp. 37-42, 1944.

"Preferred" places	Jan.[2]	Feb.	Mar.	Apr.	May	June
I	25	21	20	16	13	9
II	26	22	21	17	14	10
III	27	23	22	18	15	11
IV	1, 28	24	23	19	16	12
V	2, 29	25	24	20	17	13
XII	9	5	4, 31	27	24	20
XIII	10	6	5	1, 28	25	21
XV	12	8	7	3, 30	27	23
XVII	14	10	9	5	2, 29	25
XVIII	15	11	10	6	3, 30	26
XXII	19	15	14	10	7	3, 30
XXVI	23	19	18	14	11	7
XXVII	24	20	19	15	12	8

"Preferred" places	July	Aug.	Sept.	Oct.	Nov.	Dec.
I	6	2, 29	25	22	18	15
II	7	3, 30	26	23	19	16
III	8	4, 31	27	24	20	17
IV	9	5	1, 28	25	21	18
V	10	6	2, 29	26	22	19
XII	17	13	9	6	2, 29	26
XIII	18	14	10	7	3, 30	27
XV	20	16	12	9	5	2, 29
XVII	22	18	14	11	7	4, 31
XVIII	23	19	15	12	8	5
XXII	27	23	19	16	12	9
XXVI	4, 31	27	23	20	16	13
XXVII	5	1, 28	24	21	17	14

[2] This paper was ready on January 16, but unavoidable delays occurred in the publication of it. In the meantime, reports for January and February, 1947, indicate that these months give a favorable ratio of precipitation for "preferred" days.

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C. G. ABBOT
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THE SUN'S SHORT REGULAR VARIATION AND ITS LARGE EFFECT ON TERRESTRIAL TEMPERATURES

By C. G. ABBOT
Research Associate, Smithsonian Institution

I propose to show that there is a regular period of 6.6456 days in solar variation, and that terrestrial temperatures respond with changes ranging from 2° to 20° F. in exactly the same average period of recurrence. While the sun's variation appears to be perfectly regular in phase, always recurring on the day predicted, the terrestrial responses come sometimes for a month or more in succession from 1 to 3 days early or late. This, which by mechanical analogy we might call backlash, is doubtless the circumstance which hitherto has prevented meteorologists from recognizing the nature of this large temperature variation. When examined with the knowledge of the 6.6456-day solar period, the temperature effect is indeed so strikingly obvious, as the reader may see from figures 3 and 5, that no one could doubt that it is both real and a major element in weather. Meteorologically, this regular average periodicity appears to be a new discovery. It is not to be confused with temporary weather periods, ranging from 3 to 7 days in length and changing their phases from time to time, which have been discussed by Clayton, Arctowski, and others.

When I retired from administrative duties, in July 1944, I proposed to devote myself to the study of the records of solar variation obtained by the Smithsonian Astrophysical Observatory. I hoped to publish such detailed and thoroughgoing discussions of these observations, and of their bearing on meteorology, as might convince scientific men of the veridity of some conclusions already published. I hope the present paper will be followed by others in this field.

1. PREVIOUS STUDIES

In 1936 I published two papers on the dependence of terrestrial temperatures on solar variation.[1] It was shown that sequences of rise

[1] Smithsonian Misc. Coll., vol. 95, No. 12, 1936, and vol. 95, No. 15, 1936.

and of fall in the solar constant of radiation appeared to be indicated by Smithsonian observations. These apparently averaged 0.7 percent of the solar constant in amplitude. They appeared to be followed by regular patterns of change in the march of terrestrial temperatures. Figure 1 shows such a result. Such temperature changes were op-

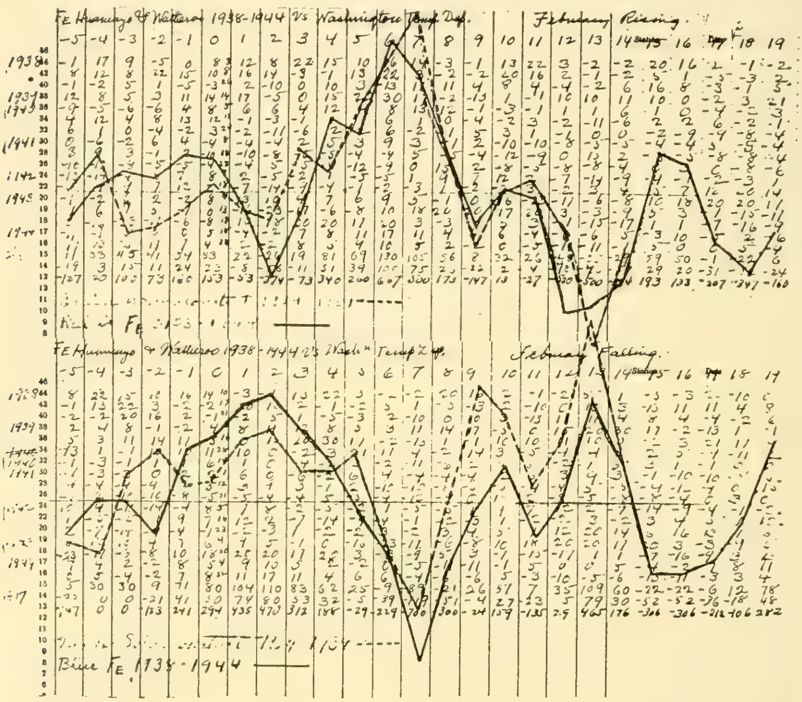


FIG. 1.—Comparison of mean march for 25 days of departures from normal temperature at Washington in February, associated (dotted curves) with ups and downs of the solar constant of radiation and (full curves) ups and downs of critical frequencies of ionization for the layer F_e. Solar change on zero day.

posite for rising and falling solar changes. They appeared to persist for at least 17 days, and were of the order of 10° F. No regularity was then discovered in the intervals between the observed solar changes, but this could have been due to the lack of many days of observation. Even at the best stations, clouds and accidental errors prevent continuous daily measurements of small changes of solar emission of radiation. Indeed meteorologists, physicists, and astronomers, with few exceptions, have remained to this day skeptical as to whether the Smithsonian observations of the solar constant really discover solar variations from day to day. They are inclined to attribute the apparent solar changes to unavoidable error.

In this prevailing atmosphere of skepticism I sought to buttress the conclusions by correlating other evidences of solar change than the solar-constant measures with weather changes. These discussions are given in two later papers.[2] In these papers I showed that changes in the areas of solar calcium flocculi observed at Ebro, Spain, and changes in the critical frequency of the ionic layer, F_e, in the atmosphere, observed at Huancayo, Peru, and Watheroo, Australia, had similar relations with terrestrial temperature changes to those connected with the solar constant. In none of these studies preceding 1946 had I been led to the discovery of a regular short period in solar variation, though longer periods from 8 months up had been discovered.[3]

2. DISCOVERY OF THE 6.6456-DAY PERIOD

I was intrigued by noticing that the temperature effects seemed to commence 2 or 3 days *before* the beginning of a change in the solar constant of radiation. As stated above, I had traced the temperature effects of a single solar change for as much as 17 days. It now occurred to me to see whether any appreciable effects lingered still longer. I therefore continued a tabulation like that shown in figure 2 of my paper "Correlations of Solar Variation with Washington Weather" (fig. 1 of the present paper) for 20 days farther forward. To my great surprise large features of weather change continued undiminished to the end. I then tabulated 20 days farther backward, so that I now had a tabulation of 65 successive days. Throughout the whole interval, large features of temperature change occurred with substantially equal prominence. On plotting the results in a curve, there appeared to be a regular period of about 6⅔ days in the march of temperature changes.

In order to fix the exact length of the period, I then obtained and tabulated departures from normal temperatures at Washington, for the months of May and November, from the year 1910 to 1945. Several periods were tried. It proved that with a period of 6.6456 days there would be no progressive shift at all in the phases of the curves from 1910 to 1945, either for May or November. As these 2 months are a half year apart, no period much longer or much shorter could suit both of them. Nevertheless individual years presented the features sometimes 1 to 3 days early, sometimes 1 to 3 days late. The four or five recurrences in a single month of any year seemed often to show no departures from regularity of phase among themselves,

[2] Smithsonian Misc. Coll., vol. 104, No. 5, 1944, and vol. 104, No. 13, 1945.

[3] Annals, Smithsonian Astrophysical Observatory, vol. 6, p. 181, 1942.

and yet the very next month might show 1 to 3 days shifting of phase from them.

I made a preliminary study of the changes in the solar constant since 1924 as observed at Montezuma, Chile. The loss of days of observation and accidental errors hindered the fixing of the phases. But I settled on January 3, 1924, as a date when the solar constant probably began to rise. This date depended on use of the period of 6.6456 days, and of all the conspicuous occasions of observed rise of solar radiation occurring in all months from 1924 to 1944. As I shall show, January 3, 1924, did not prove finally to be a date when the solar constant began to rise, but a date near maximum of periodic variation. However, it is as good a date as any to base my tabulations upon, and all the work about to be displayed is based on January 3.0000, 1924.

3. TEMPERATURE TABULATIONS

To fix ideas, I now employ tables and charts. For the convenience of any who may wish to use the periodicity I have discovered, table 1

TABLE 1.—*Corresponding dates in 1924 for successive cycles of 6.6456 days*

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
3.0000	5.2280	2.8104	5.0384	1.6208	3.8488	7.0768	2.6592	4.8872	1.4696	3.6976	6.9256
9.6546	11.8736	9.4560	11.6840	8.2664	10.4944	13.7224	9.3048	11.5328	8.1152	10.3432	13.5712
16.2912	18.5192	16.1016	18.3296	14.9120	17.1400	20.3680	15.9504	18.1784	14.7608	16.9888	20.2168
22.9368	25.1648	22.7472	24.9752	21.5576	23.7856	27.0136	22.5960	24.8240	21.4064	23.6344	26.8624
29.5824	......	29.3938	......	28.2032	30.4312	......	29.2416	......	28.0520	30.2800	......

contains all the periodic zero-dates in the year 1924, as I have used them.

Since 55 cycles of 6.6456 days comprise 365.5080 days, we may obtain corresponding dates in any year next succeeding a year in which we know the periodic dates, by the following simple rules. For the 10 months, March to December, add 0.5080 day to give the new dates, except for leap years. In case the next succeeding year is to be a leap year, subtract 0.4920 day to give corresponding dates in these 10 months in such leap years. For the months January and February, add 0.5080 day, unless the year when dates are known is a leap year. In such cases of leap years, subtract 0.4920 day to obtain corresponding dates in January and February, in years next succeeding leap years.

The decimal parts of days serve to indicate the nearest whole number date. If the fraction is less than 0.5, use the integer of the date as found. If over 0.5, use the next larger integer in tabulations.

I now give, in table 2, a sample tabulation for the month of March

TABLE 2.—*Washington temperature departures of March 1936, tabulated in cycles of 6.6456 days. The first line gives the number of days preceding and following the zero dates given in the first column for which values of temperature departures published by the Weather Bureau are tabulated below*

Zero dates	−5	−4	−3	−2	−1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
6th	−2°	−4°	3°	13°	7°	−3°	−2°	2°	14°	16°	15°	5°	−2°	8°	18°	22°	15°	5°	1°	2°
13th	2	14	16	15	5	−2	8	18	22	15	5	1	2	1	8	8	13	13	8	8
19th	8	18	22	15	5	1	2	1	8	8	13	13	8	8	10	12	15	9	0	0
26th	1	8	8	13	13	8	8	10	12	15	9	0	0	−10	−9	0	14	−4	−11	−9
Mean	2.2°	9.0°	12.7°	14.0°	7.5°	1.0°	4.0°	7.7°	14.0°	13.5°	10.5°	4.7°	2.0°	1.7°	6.7°	10.5°	16.2°	5.7°	−0.5°	0.2°

1936, and in figure 2 a graph of the mean march of temperature departures for 20 days each, at Washington, associated with four cycles of 6.6456 days each, occurring in that month. These data show a very regular periodic march of about 14° amplitude, and, as nearly as the mean of so few cases can indicate, of about 6.5 days period.

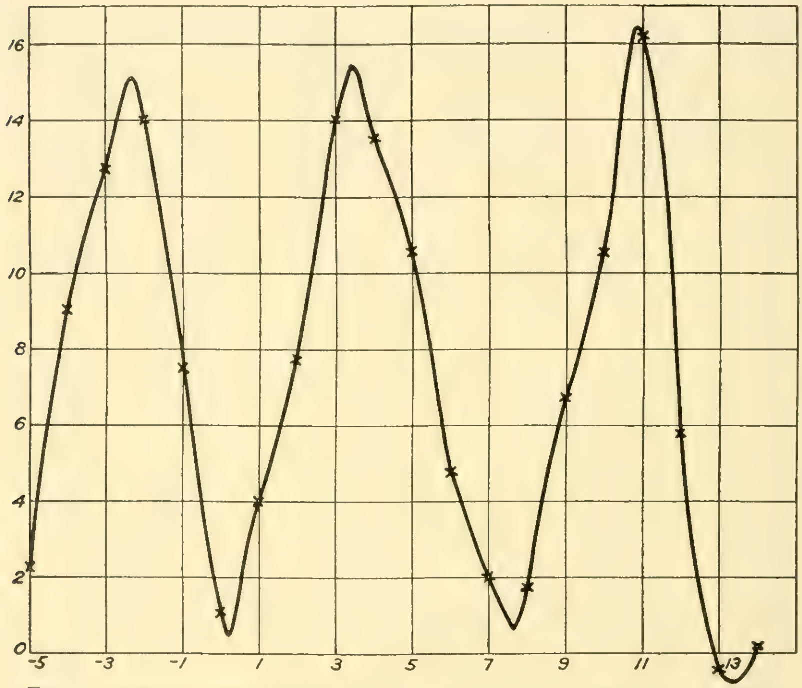


FIG. 2.—Separate data and mean march of temperature departures in Washington for four cycles of 6.6456 days each, occurring in March 1936. Abscissae, days from zeroth day of cycle; ordinates, degrees Fahrenheit. (See table 2.)

I have performed exactly similar operations on all the cycles of 6.6456 days in all months in all years from 1910 to 1945. All monthly temperature data, so treated, agree to indicate the veridity of the cycle of 6.6456 days. Comparing the results of individual months in successive years, 1910 to 1945, there appears no *progressive* shift, accumulating to as much as 1 day, from 1910 to 1945. But there do appear in individual years phase shiftings of from 1 to 3 days from the calculated positions. During any individual month, in any individual year, the four or five recurrences of the cycle usually return approximately in the same phase, without shifting. But comparing the results of one year with those of another, such phase shiftings as have just been spoken of do occur. A cursory inspection did not indicate any law governing these phase shiftings. They did not seem to be correlated with any suggested variable, such, for instance, as the sunspot cycle. I reserve the matter, though, for later consideration.

4. GRAPHICAL ILLUSTRATIONS

To show these results more clearly, I give in figure 3 all the plots similar to figure 2, derived from Washington temperature records of October of all years, 1910 to 1945. It will be obvious to all who examine these results for the years 1910, 1912, 1914, 1915, 1917, 1921, 1922, 1924, 1926, 1928, 1929, 1930, 1931, 1932, 1934, 1935, 1936, 1937, 1938, 1939, 1940, 1941, 1942, 1943, and 1944 that, though individually the curves represent means of only four or five recurrences of the period in each of those years, and cannot be expected to be smooth, they are perfect enough to indicate it clearly as a real and important phenomenon of meteorology. It is indeed surprising, in view of the opinion which has so long prevailed (namely, that the details of changes in weather are attributable almost wholly to terrestrial influences) that this solar influence should stand out so strongly against all terrestrial competition.

The displacements of phase, above referred to, from year to year, but the usual approximate constancy of phase in any month within a given year, may be realized by looking down any vertical column of figure 3. Compare, for instance, in the first column the results for the years 1910, 1914, 1922, 1926, 1930, 1934, 1938, and 1942. The shiftings of phase are obvious. And yet see how the curves for 1914, 1918, 1922, 1926, and 1942 covering 28 years altogether, find themselves in almost identical phases, verifying the accuracy of the average period, 6.6456 days. Results of other years could be added to this list of curves in similar phase from other columns of figure 3, as, for instance, 1911, 1931, 1935; 1924, 1936; 1913, 1917, 1921, 1929, and 1937; in all of which years the phases agree closely with the group beginning with 1914, cited above from column 1.

The amplitudes in figure 3 are of especial interest. They range from less than 2° F. in 1933 to 12° F. in 1915 and 1943. As I shall show later, this great range of amplitudes in the temperature effects of this periodic solar variation does not seem to be associated with appreciable change of amplitudes in the solar-constant variations. This tends to indicate that the temperature effect is not a *direct* heat phenomenon.

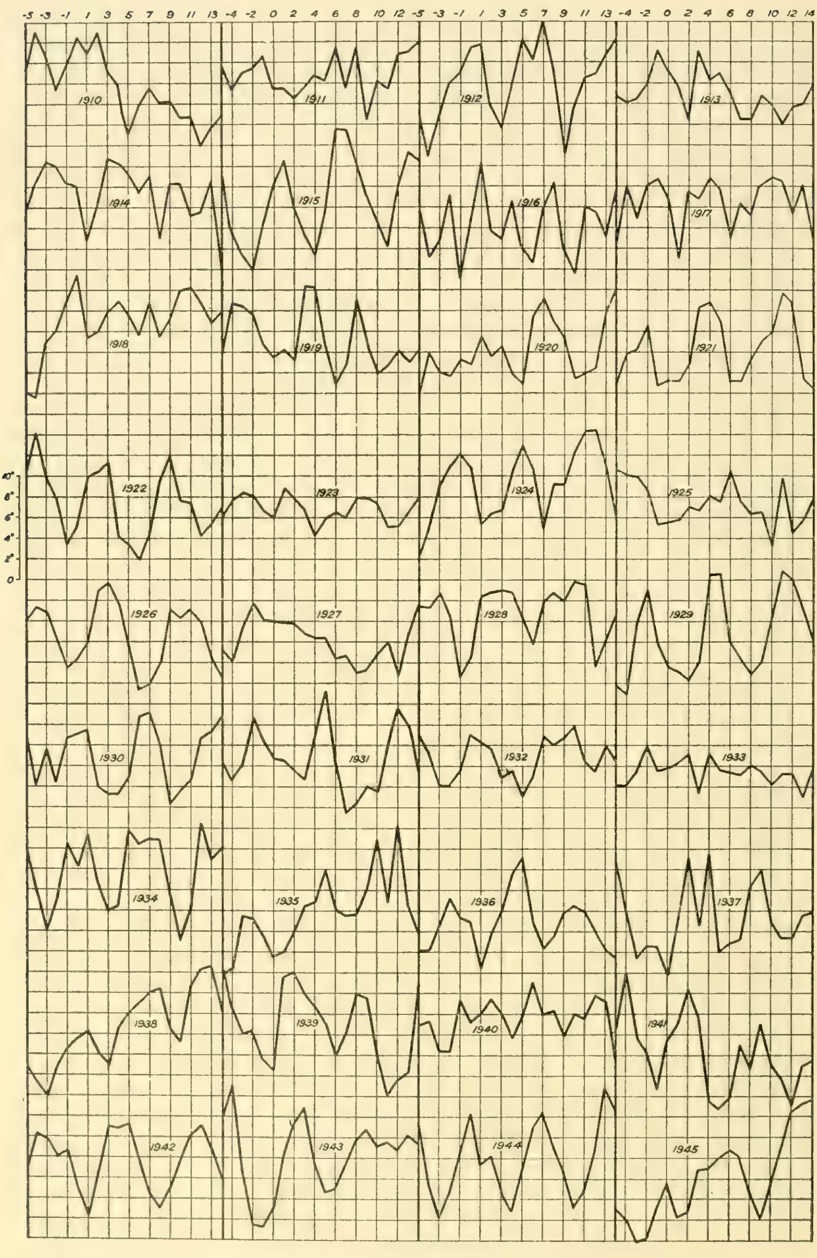


FIG. 3.—Graphs derived as in table 2 and figure 2 for each month of October from the year 1910 to 1945. Scale of ordinates, 0° to 10°, on the left.

5. AMPLITUDES OF TEMPERATURE EFFECTS, AND PHASE SHIFTINGS

Owing to the phase shiftings from year to year, just remarked upon, it is necessary to allow for them when computing the true average amplitudes of the temperature effects resulting from the 6.6456 cycle. To do this, I plotted for each month of the year, and for all years from 1910 to 1945, the mean march of the temperature effect as determined from the four or five recurrences of the cycle in the given month. Such a graph, for the month of October only, is shown in figure 3. From all the graphs I read off individually the positions in the 20-day tabulations (such as that of table 2) when the three maxima of such a tabulation occurred. Obtaining for these three places the mean of all 36 years, I computed departures from these means for all the cases individually. I found then the nearest integral measures, in days, of the shifts required to bring all the tabulations to approximately identical phases from 1910 to 1945. To fix ideas I give, in table 3, the calculations made of these mean shifts for the month of March. I remark here that there is some uncertainty about these computed phase shiftings. A shift forward by 3 days, for instance, is for my purposes the same as a shift backward of $3\frac{1}{2}$ days.

In table 4, using these mean shifts, I compute the mean marches and amplitudes of the temperature departures for March, due to the 6.6456-day cycle. The lacunae in table 4 are due to the shifts made. Owing to them, the extremities of the corresponding curves in figure 4 are only approximate, from -5 to -4, and from 13 to 14. From -3 to $+12$ the curves show accurately the average effect, in March, of the 6.6456-day period. The mean amplitude for March is $4^\circ\!.8$ F., but for individual years the mean amplitudes vary, in March, from 2° to 18° F. Smallest amplitudes occurred in March in the years 1915, 1926, 1942, and 1944. Largest amplitudes occurred in March in 1921, 1936, and 1943. The corresponding curves will be found in figure 4. Similar tables to table 4 have been computed for all months of the year from Washington temperature records. In figure 5 I give the mean curves for all months, covering the years 1910 to 1945. The reader perhaps is surprised that the mean curves do not certainly indicate changes of phase from month to month. It might be expected that the lag of temperature response to solar change would differ with the season of the year. There is indeed a range of about 2 days in the phases of the monthly curves shown in figure 5, but it is not quite certain that this is not introduced mathematically in the correction of phase differences, as shown in table 3. On the other hand there is a very obviously real difference in the amplitudes of variation. The ordinates of the mean curves of temperature departures range from 2°.5 F. in July to 6°.5 F. in January.

TABLE 3.—*Position of maxima by years. March values. Mean positions, 1910 to 1945, and deviations from the mean. Mean shift of phases in nearest whole number days*

Year	Positions of maxima			Deviations from mean			Comparative shift
1910....	......	5.0	.....	.....	0.2	.....	0
1911....	0.0	.....	.....	1.6	.....	.....	2
1912....	0.0	6.5	11.5	1.6	1.7	0.4	2
1913....	......	6.5	.....	.....	1.7	.....	2
1914....	......	.....	10.5	.....	.....	−0.6	−1
1915....	......	.....	.....	.....	.....	.....	(−1)
1916....	−1.0	5.0	11.5	0.6	0.2	0.4	0
1917....	−3.0	3.5	10.0	−1.4	−1.3	−1.1	−1
1918....	−2.5	4.0	10.5	−0.9	−0.8	−0.6	−1
1919....	......	2.5	9.5	.....	−2.3	−1.6	−2
1920....	−3.5	3.0	9.5	−1.9	−1.8	−1.6	−2
1921....	−2.0	4.5	11.0	−0.4	−0.3	−0.1	0
1922....	−3.0	4.0	11.0	−1.4	−0.8	−0.1	−1
1923....	0.0	6.0	12.5	1.6	1.2	1.4	1
1924....	0.5	7.0	13.5	2.1	2.2	2.4	2
1925....	−4.0	2.5	9.0	−2.4	−2.1	−2.1	−2
1926....	......	.....	9.0	.....	.....	−2.1	−2
1927....	1.0	7.0	13.0	2.6	2.2	1.9	2
1928....	......	.....	.....	.....	.....	.....	(−2)
1929....	−4.0	3.0	9.0	−2.4	−1.8	−2.1	−2
1930....	0.5	6.5	12.5	2.1	1.7	1.4	2
1931....	......	2.0	9.5	.....	−2.8	−1.6	−2
1932....	−0.5	7.0	13.5	1.1	2.2	2.4	2
1933....	−4.0	2.5	9.0	−2.4	−2.3	−2.1	−2
1934....	1.0	7.5	14.0	2.6	2.7	2.9	3
1935....	−3.0	3.0	10.0	−1.4	−1.8	−1.1	−1
1936....	−2.5	3.5	10.5	−0.9	−1.3	−0.6	−1
1937....	−1.0	6.0	11.5	0.6	1.2	0.4	1
1938....	−0.5	6.0	12.5	1.1	1.2	1.4	1
1939....	−1.0	5.0	12.0	0.6	0.2	0.9	1
1940....	0.0	7.5	13.0	1.6	2.7	1.9	2
1941....	−3.5	2.0	9.0	−1.9	−2.8	−2.1	−2
1942....	−3.5	.....	9.5	−1.9	.....	−1.6	−2
1943....	−2.5	3.5	10.0	−0.9	−1.3	−1.1	−1
1944....	......	.....	11.0	.....	.....	−0.1	0
1945....	......	5.0	12.0	.....	0.2	0.9	1
Number	26	30	32				
Sum....	−42.0	143.0	354.0				
Mean...	−1.6	4.8	11.1				

6. COMPARISON OF TEMPERATURE EFFECTS IN WIDELY SEPARATED STATIONS

It is of interest to compare these results for Washington with similar ones for other stations. Not to delay this publication unduly by a long period of computation, I have contented myself, for the present, with employing only the stations Helena, Mont., and St. Louis, Mo., and have computed only for January and October. Only years from 1924 to 1943 have been used for these stations. Nothing surprising resulted from these tabulations. The temperature effects were as obvious as for Washington, and of the same order of amplitude. Shiftings of phase were found of the character explained above, and wide ranges of amplitude were found in different years. Employing only years in which the curves were very well defined at both stations com-

TABLE 4.—*Yearly mean temperature departures at Washington. March values, and general mean, 1910 to 1945, for March*

Days	—5	—4	—3	—2	—1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1910	7°0	9°2	7°0	3°5	9°2	13°0	5°5	5°2	9°5	8°0	8°0	8°2	11°0	4°7	7°7	15°0	10°7	9°0	9°2	9°0
1911	—9.7	—2.0	0.5	3.5	—1.5	0.2	—6.0	—8.0	—1.2	—4.2	0.2	—1.7	—3.0	—2.7	—1.7	—8.7	—4.2	0.5	....	....
1912	—7.2	—3.5	—2.5	—0.2	0.0	1.2	0.7	—2.7	0.7	4.0	6.5	—1.7	3.2	1.5	4.0	4.5	2.2	2.2	....	....
1913	7.7	10.5	6.7	4.5	6.5	4.2	1.5	3.0	10.7	9.2	15.0	9.0	1.2	0.7	0.7	5.2	2.7	5.0	....	....
1914	....	—9.8	—5.2	—4.2	—5.6	—4.2	—3.0	—2.4	—2.2	2.0	—3.0	—4.0	—1.6	—4.6	—4.8	0.4	—1.2	—1.4	—0.4	4.6
1915	....	2.8	—1.4	—1.2	—5.0	—3.8	—3.6	—2.6	—5.0	—4.4	—3.8	—4.4	—6.0	—4.4	—2.8	—2.4	—1.4	—4.2	—3.0	—1.0
1916	—6.6	—6.8	—11.4	—4.2	—5.8	—1.6	—4.6	—9.4	—6.8	—4.0	—0.8	—2.6	—3.8	—8.2	—4.8	—4.6	—3.4	—3.4	—5.6	—7.8
1917	....	2.0	3.4	3.2	—1.6	1.6	2.0	1.0	0.8	4.2	3.6	1.6	0.8	2.2	1.2	1.6	4.2	2.6	0.4	—3.2
1918	....	8.4	3.4	8.8	11.8	4.6	4.0	3.8	2.0	7.4	10.6	8.2	4.6	4.4	0.8	1.8	7.4	7.6	3.4	—1.6
1919	....	....	9.4	6.0	4.2	3.6	2.4	2.2	5.6	4.6	0.4	2.8	3.0	—1.0	2.6	5.6	3.8	2.4	3.8	0.6
1920	....	....	1.8	2.2	3.0	—3.0	—4.2	—2.0	3.8	8.2	4.8	4.0	2.4	—2.2	—0.6	4.8	5.6	5.0	3.8	0.4
1921	2.2	10.6	16.0	21.0	19.6	9.6	3.8	5.0	9.2	18.2	22.2	15.0	7.8	5.2	9.2	8.8	15.8	12.0	2.0	4.8
1922	....	1.2	7.2	6.4	4.6	1.6	0.6	0.2	2.6	5.4	6.0	4.6	—0.2	—1.4	0.2	1.4	7.6	9.6	8.2	4.4
1923	3.0	—1.8	—2.2	3.0	8.8	1.0	—1.6	—0.6	2.2	3.0	3.6	3.0	—2.0	—1.0	—2.2	0.2	2.4	9.2	—3.6	....
1924	—2.0	—3.2	—1.0	2.0	3.2	—0.4	—2.2	—4.2	—3.6	0.4	1.4	—1.2	—2.8	—3.2	—5.6	—3.0	1.8	3.6	....	....
1925	....	....	5.8	4.6	6.4	2.2	—1.2	—3.0	6.4	7.0	3.2	9.6	2.8	—0.6	0.0	8.0	7.4	1.0	6.2	0.6
1926	....	....	—1.4	—4.2	0.2	—5.2	—4.6	—1.2	—1.2	—3.8	—0.4	—4.4	—4.4	0.2	—3.0	1.4	1.0	0.2	—3.4	—1.8
1927	4.6	2.2	1.4	3.6	5.4	5.8	3.8	3.2	0.0	3.6	5.4	4.4	1.0	0.6	0.0	0.2	3.6	2.0	....	....
1928	....	....	1.6	4.4	3.0	2.0	0.8	—0.6	—0.8	—1.4	1.4	1.6	4.4	4.8	3.2	3.8	4.2	1.6	0.4	2.0
1929	....	....	11.2	9.6	7.6	6.0	1.4	7.2	10.6	10.4	10.6	12.6	9.4	5.6	9.8	16.6	10.2	10.2	11.2	10.4
1930	—1.8	—0.6	3.6	5.4	5.4	2.0	—1.4	0.8	4.0	4.6	5.4	0.8	—3.0	—3.2	3.4	7.4	6.8	2.4	....	....
1931	....	....	2.0	0.7	—3.2	—3.2	—2.7	—1.2	0.5	1.2	—1.7	—2.2	—4.2	—2.5	—3.2	—1.0	0.7	0.0	—3.0	—4.0
1932	—5.2	—3.6	1.2	1.0	—0.8	—3.4	—6.4	—5.4	—2.2	—0.6	0.0	2.4	—2.6	—5.4	—3.4	1.2	—0.6	2.2	....	....
1933	....	....	7.0	4.2	1.5	—1.2	—3.0	—3.7	0.0	6.0	3.0	—1.5	—2.5	—3.0	1.5	4.0	6.2	0.7	—1.5	4.0
1934	—1.2	7.7	—0.2	1.5	—2.5	—0.2	—5.7	—7.2	—6.2	4.2	7.0	—2.0	—3.5	—1.5	0.5	—0.2	8.0	....	....	....
1935	....	6.0	11.7	9.2	7.5	6.0	8.2	9.0	4.7	9.0	9.2	4.0	2.0	3.5	6.7	4.0	11.0	4.2	—4.2	—0.2
1936	....	—2.2	9.0	12.2	14.0	7.5	1.0	7.7	7.7	14.0	13.5	10.5	4.7	2.0	1.7	6.7	10.5	14.2	5.7	—0.5
1937	—2.2	—0.2	1.0	4.7	1.2	—3.5	—3.2	—3.7	—3.0	0.2	—2.5	0.2	—4.5	—3.2	—1.0	2.2	2.5	—0.2	—1.0	....
1938	5.7	0.7	6.5	11.7	9.2	6.5	7.5	8.7	7.7	7.7	11.2	7.0	5.7	6.2	4.7	1.7	5.5	5.0	2.2	....
1939	0.8	2.8	8.4	11.2	5.6	0.0	1.8	5.6	6.4	5.6	5.2	—0.6	1.0	0.4	2.8	1.6	1.6	3.4	1.4	....
1940	—5.5	—5.5	—2.2	2.2	—2.0	—2.5	—2.2	—3.5	—4.7	—2.0	—1.2	0.0	—4.7	—2.7	—1.2	1.0	4.0	—0.2	....	....
1941	....	....	—0.2	2.6	4.2	—5.2	—5.0	—3.6	—1.4	2.2	—3.4	—6.4	—2.6	—1.6	—2.0	—2.8	—0.4	—1.6	—4.0	—2.8
1942	....	....	1.8	7.0	6.8	3.8	4.6	5.4	1.0	4.2	6.0	4.2	5.2	7.8	7.8	5.4	8.8	8.4	2.6	2.0
1943	....	—0.6	0.8	6.8	5.4	—0.6	—3.2	—3.4	2.0	10.4	11.8	3.0	—6.6	—4.2	5.6	7.2	6.2	7.6	3.6	—1.2
1944	6.2	4.0	2.8	1.4	—1.2	0.2	—0.6	1.6	0.8	—2.6	0.6	—0.6	0.0	—2.0	1.0	2.8	3.0	3.8	1.4	—1.2
1945	11.8	11.0	11.2	11.2	8.8	18.0	16.0	11.0	14.8	15.8	13.6	13.0	15.6	12.6	10.6	14.2	18.8	16.8	14.4	....
Number	18	26	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	35	27	22
Sum	76	393	1139	1653	1339	626	132	122	754	1493	1626	964	412	58	494	1160	1730	1414	502	175
Mean	0°42	1°51	3°16	4°59	3°72	1°74	0°37	0°34	2°09	4°15	4°52	2°68	1°14	0°16	1°37	3°22	4°81	4°04	1°86	0°79

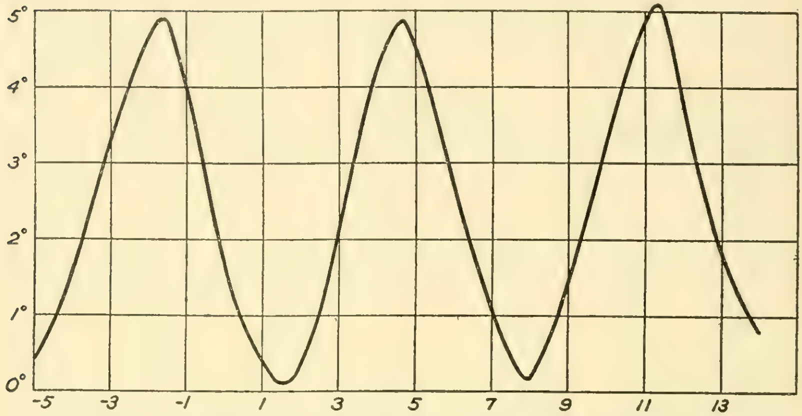


FIG. 4.—Average effects of the 6.6456-day period on Washington temperature departures for all months of March from the year 1910 to 1945. From 20-day tabulations.

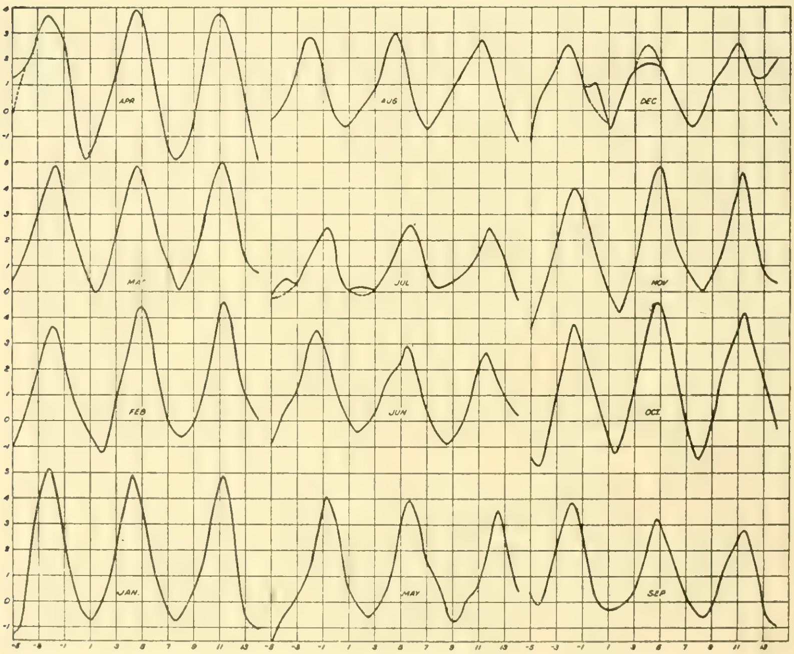


FIG. 5.—Graphs derived as in table 4 and figure 4 for mean effects of the 6.6456-day period on Washington temperature departures in all months of all years from the year 1910 to 1945. Ordinates are degrees Fahrenheit.

pared, I found that the temperature effects usually occurred in these western cities some days earlier than at Washington, as was expected. These delays average nearly in accord with the findings of H. H. Clayton [4] from a study of the progress of a 7-day wave of atmospheric disturbance from Alaska to the Atlantic coast. Figure 6 gives the mean temperature effects for January and October at Helena and St. Louis for the years 1924 to 1943.

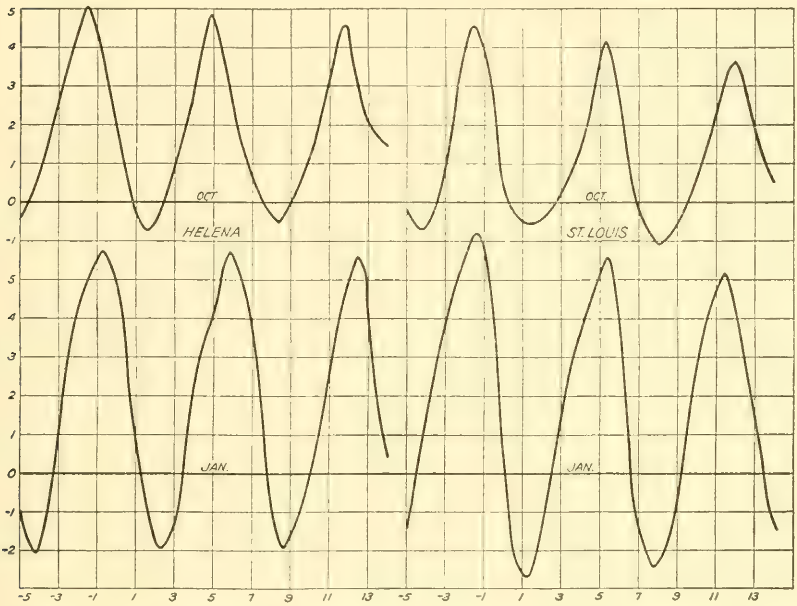


FIG. 6.—Graphs derived as in table 4 and figure 4, for mean effects of the 6.6456-day period on St. Louis and Helena temperature departures for months of January and October of all years from the year 1924 to 1943. Ordinates are degrees Fahrenheit.

7. THE 6.6456-DAY PERIOD IN THE SOLAR EMISSION

Leaving temperature records for the moment, I pass now to the determination of the actual changes in the emission of radiation of the sun itself, which accompany these large periodic changes in the temperature at Washington and elsewhere. I shall employ extensively the solar-constant measures of Montezuma, Chile, 1924 to 1944, to determine these solar changes.

Between January 1924 and December 1944 there were about 1,150 recurrences of the period of 6.6456 days. There dates have all been

[4] Smithsonian Misc. Coll., vol. 82, No. 7, fig. 14, p. 22, 1930.

computed as based on the date January 3.0000, 1924, which is my fiducial starting point. It is useless to employ in this study any measurements of the solar constant of radiation other than those observed at the best Smithsonian station, namely, Montezuma, Chile. Results of other stations are too inaccurate. To include them would defeat our purpose.

8. TABULATIONS OF MONTEZUMA SOLAR-CONSTANT DATA

For each month of the year I made a separate tabulation of the solar-constant values from Montezuma, from 8 days before to 11 days after each zeroth date of recurrence of the period of 6.6456 days, computed from January 3.0000, 1924. Unfortunately a great many days are missing from the record. In many recurrences of the period the missing days are so numerous that these incompletely recorded recurrences must be thrown out. Only 310 cases, and these all in the 9 months March to November, were thought complete enough to be retained.

It remained to decide whether to fill up the dates missing in the 310 cases retained. After consideration this appeared necessary. For the solar constant varies from about 1.930 to about 1.965 frequently, and sometimes beyond these limits. The mean values of successive columns of a tabulation covering numerous groups of values, of 20 successive days each, would not be comparable if some of these columns missed a number of high values, and other columns missed a number of low values, because of unfavorable observing conditions. Accordingly I interpolated missing values to harmonize best with values next preceding and next following them. Besides these there were a few wild values, clearly incorrect when compared to those preceding and following. Interpolated values were substituted for them also. The number of scattering interpolated values was counted, and it proved to be about 3/10 of the whole number of days covering the 310 retained recurrences of the 6.6456-day period. Forasmuch as the interpolated values could not have a part in determining the true solar variation, the amplitude of the mean resulting variation is to be multiplied by 10/7, to give what it would be if the record were complete.

9. QUESTIONS REGARDING THE SUN'S EMISSION, AND METHODS OF INVESTIGATION THEREOF

The following questions were to be solved:

1. What is the form and amplitude of the mean curve, 1924 to 1944, of the sun's periodic variation of radiation?

2. How are its phases related to January 3.0000, 1924?

3. Are its amplitudes variable, and, if so, have their variations a correlation with variations of amplitudes in temperature effects?

4. Are the displacements of phases in periodic curves of temperature departures, above referred to, found to be duplicated in direct solar measurements?

Before giving the results, a few remarks are due regarding the accuracy of the solar-constant observations, in relation to the amplitude of the expected solar variations. In my papers of 1936, I estimated the average amplitude of the short-interval rises and falls of solar radiation as about 0.7 percent. Only the *larger* variations could possibly be discerned individually there, owing to accidental errors and incompleteness of the solar-constant record. Furthermore, whenever accidental errors occurred of a sign tending to increase the amplitudes of the apparent solar changes, they of course made the changes more conspicuous, and the inclusion of these spuriously excessive changes tended to raise my estimate of the average amplitude of variation. Hence the estimate, 0.7 percent, is far above what must now be expected, when every possible occasion of solar change is included. It must be realized that *all* recurrences of the cycle have been computed in the present research, and the 310 cases included in the mean are in no way selected for large or small amplitudes of solar variation.

As shown at page 183, volume 6, Annals of the Astrophysical Observatory, the probable error of a solar-constant value, determined from a single day of observation at one station, is 0.16 percent. Hence if the average change to be expected is of the order of 0.2 percent, a *single month* of my tabulations for the 21 years, containing only about 30 *observed* values in a column (neglecting those interpolated for symmetry's sake) cannot be expected to give a fair representation of the true form of the solar variation curve. For some of its points will probably be too low by 0.09 percent,[5] and others too high by this amount. Hence 1 month alone will be very unlikely to give a convincing answer to our first query. But if we combine the average results of all 9 available months, there will be the mean of nearly 300 observed values for each point of the mean curve, and these means should be three times more conclusive than results of one month only.

Remarks are also in order regarding queries numbered 3 and 4. Regarding query 3, as we have seen in figure 3, there is a great dif-

[5] Thus: $\frac{3 \times 0.16}{\sqrt{30}} = 0.09$. Errors three times the probable error, as is well known, occasionally occur.

ference in the amplitudes of the temperature effects of the cycle. Naturally, therefore, I separated the solar-constant data into two groups, one corresponding with occasions when large amplitudes of temperature change appeared, and the other for small amplitudes. This segregation, I hoped, would indicate whether solar or terrestrial causes produced the differences of amplitude.

Regarding query 4, I made two reductions of the solar-constant data. In one I arranged the tabulation so that corresponding computed dates ran vertically, without phase shifting, in the monthly tables. In the other I used the same phase displacement corrections of the data which I had used so successfully with the temperatures, as illustrated above in tables 3 and 4. If now, the second tabulation should give larger and more consistent mean amplitudes of solar change than the first, it would appear that the solar periodic variation, like the temperature variation, was but quasi-periodic after all, and truly periodic only in the mean over long intervals of time. In such a case, though the period 6.6456 was found to persist as a general mean, the individual recurrences of it in the sun's radiation would appear subject to displacements of phase.

With these explanations given, I now proceed to the results.

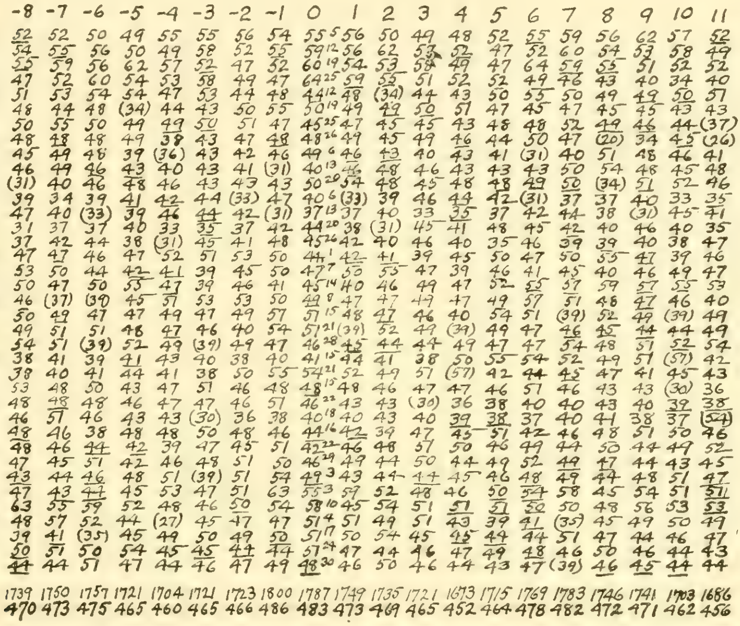
10. RESULTS OF TABULATIONS OF SOLAR VARIATION

In figure 7 I give a photographic reproduction of my tabulation of solar constants for the month of September, 1923 [6] to 1944. The data used, when available, are "Preferred Solar-Constant Values" from table 24 of volume 6, Annals of the Smithsonian Astrophysical Observatory. For accuracy's sake Montezuma values only are to be used. Hence if more than one station contributed to the "preferred" value, it is discarded, and the mean of the Montezuma values for the day is substituted. The reader will understand that the solar-constant value is the number in the text and in figure 7, prefixed by 1.9. The values from October 1939 to December 1944 are from unpublished results, kindly communicated by the Director of the Astrophysical Observatory, L. B. Aldrich. In figure 7 all interpolated values are underlined, as for example, "1923, −8, 52." Parentheses about a value indicate that, though observed, it is so wild that its inclusion would falsify the result. Thus: "1925, +2, (34)." In such cases an interpolated value was used. In the case just cited, 46 was interpolated.

From the mean values at the bottom of the tabulation the graph,

[6] Several months of the year 1923 are included in table 24 of volume 6 of the Annals and are used here. The year 1944 yielded no favorable cases.

figure 8, is drawn. As just stated, the reader will have noted from Annals, volume 6, that the figures 1.9 are to be understood as prefixed to all values of the solar constant printed. Hence, the amplitude of variation shown for September results, in figures 7 and 8, is from 1.9452 to 1.9486, or 0.17 percent. In figure 9 I give the general



	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11
1923	52	52	50	49	55	55	56	54	55^{5}	56	50	49	48	52	55	59	56	62	57	52
	54	55	56	50	49	58	52	55	59^{12}	56	62	53	52	47	52	60	54	53	58	49
	55	59	56	62	57	52	47	52	60^{19}	54	53	58	49	47	64	59	55	51	52	52
	47	52	60	54	53	58	49	47	64^{25}	59	55	51	52	52	49	46	43	40	34	40
1925	51	53	54	54	47	53	44	48	44^{12}	48	(34)	44	43	50	55	50	49	49	50	51
	48	44	48	(34)	44	43	50	55	50^{19}	49	49	50	51	47	45	47	45	45	43	43
	50	55	50	49	49	50	51	47	45^{25}	47	45	45	43	48	48	52	49	46	44	(37)
1926	48	48	48	49	38	43	47	48	48^{26}	49	45	49	46	44	50	47	(20)	34	45	(26)
1927	45	49	48	39	(36)	43	42	46	49^{6}	46	43	40	43	41	(31)	40	51	48	46	41
	46	49	46	43	40	43	41	(31)	40^{13}	46	48	46	43	43	43	50	54	48	45	48
	(31)	40	46	48	46	43	43	43	50^{20}	54	48	45	48	48	49	50	(34)	51	52	46
1929	39	34	39	41	42	44	(33)	47	40^{6}	(33)	39	46	44	42	(31)	37	37	40	33	35
	47	40	(33)	39	46	44	42	(31)	37^{13}	37	40	33	35	37	42	44	38	(31)	45	41
	31	37	37	40	33	35	37	42	44^{20}	38	(31)	45	41	48	45	42	40	46	40	35
	37	42	44	38	(31)	45	41	48	45^{26}	42	40	46	40	35	46	39	39	40	38	47
1933	47	47	46	47	52	51	53	50	44^{1}	42	41	39	45	50	47	50	55	47	39	46
	53	50	44	42	41	39	45	50	47^{7}	50	55	47	39	46	41	45	40	46	49	47
	50	47	50	55	47	39	46	41	45^{14}	40	46	49	47	52	55	57	59	57	55	53
1934	46	(37)	(39)	45	51	53	53	50	49^{8}	47	47	49	47	49	57	51	48	47	46	40
	50	49	47	47	49	47	49	57	51^{15}	48	47	46	40	54	51	(39)	52	49	(39)	49
	49	51	51	48	47	46	40	54	51^{21}	(39)	52	49	(39)	49	47	46	45	44	44	49
	54	51	(39)	52	49	(39)	49	47	46^{28}	45	44	44	49	47	47	54	48	51	52	54
1936	38	41	39	41	43	40	38	40	41^{15}	44	41	38	50	55	54	52	49	51	(57)	42
	38	40	41	44	41	38	50	55	54^{21}	52	49	51	(57)	42	44	45	47	41	45	43
1937	53	48	50	43	47	51	46	48	48^{15}	48	46	47	47	46	51	46	43	43	(30)	36
	48	48	48	46	47	47	46	51	46^{22}	43	43	(30)	36	38	40	40	43	40	39	38
	46	51	46	43	43	(30)	36	38	40^{18}	40	43	40	39	38	37	40	41	38	37	(54)
1938	48	46	38	48	48	50	48	46	44^{16}	42	39	47	45	51	42	46	48	51	50	46
	48	46	44	42	39	47	45	51	42^{22}	46	48	57	50	46	49	44	50	44	49	52
	47	45	51	42	46	48	51	50	46^{29}	49	44	50	44	49	52	49	47	44	43	45
1939	43	44	46	48	51	(39)	51	54	49^{3}	43	44	44	45	46	48	49	44	48	51	47
1941	47	43	44	45	53	47	51	63	55^{3}	59	52	48	46	50	54	58	45	54	51	51
	63	55	59	52	48	46	50	54	58^{10}	45	54	51	51	51	50	50	48	56	53	53
1943	48	57	52	44	(27)	45	47	47	51^{4}	51	49	51	43	39	41	(35)	45	49	50	49
	39	41	(35)	45	49	50	49	50	51^{17}	50	54	45	45	44	44	51	47	44	46	47
	50	51	50	54	45	45	44	44	51^{24}	47	44	46	47	49	48	46	50	46	44	43
	44	44	51	47	44	46	47	49	48^{30}	46	50	46	44	43	47	(39)	46	45	44	44
	1739	1750	1757	1721	1704	1721	1723	1800	1787	1749	1735	1721	1673	1715	1769	1783	1746	1741	1703	1686
	470	473	475	465	460	465	466	486	483	473	469	465	452	464	478	482	472	471	462	456

FIG. 7.—Photographic reproduction of original computation of the average variation of the solar constant of radiation in all months of September from the year 1923 to 1944, as influenced by the period of 6.6456 days. No shifting of phase admitted.

weighted mean of such tabulations as the September tabulation of the solar-constant values for the 9 months March to November, 1924 to 1944. The actual sums and mean values are given in table 5, together with the general mean multiplied by 10/7 as suggested above. These last values determine the upper curve in figure 9. Its amplitude of variation is but 0.13 percent.

11. AMPLITUDE AND NATURE OF THE SOLAR VARIATION OF THE 6.6456-DAY PERIOD

It will be noted that the final mean amplitude of solar variation in the 6.6456-day period, 0.13 percent, is even less than the probable error of a single day of observation of the solar constant at one station,

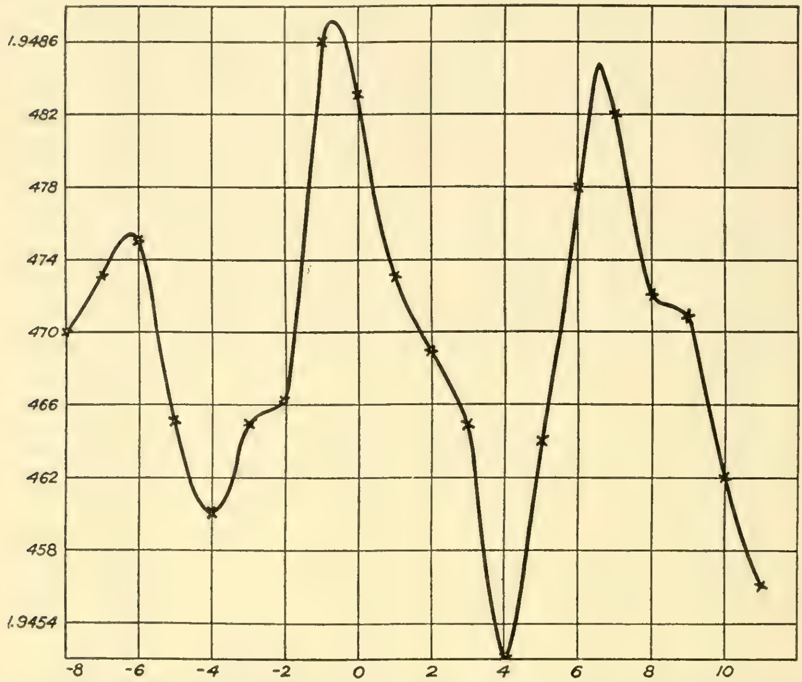


FIG. 8.—Mean march of variation of the solar constant attending the 6.6456-day period, as computed in figure 7 from Montezuma observations of all months of September from the year 1923 to 1944.

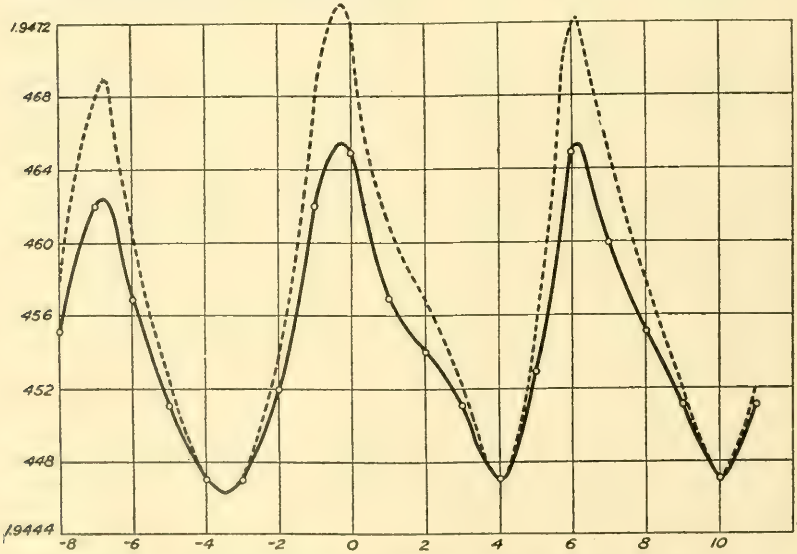


FIG. 9.—Mean march of variation of the solar constant, as derived in figures 7 and 8, for all months, March to November, of all years from 1924 to 1944, corresponding to the data in table 5. Upper dotted curve 10/7 the amplitude of the mean curve, to allow for lacunae in the observations as explained in the text.

TABLE 5.—*Mean results on the 6.6456-day periodicity in the solar constant of radiation*

Days:	−8	−7	−6	−5	−4	−3	−2	−1	0	1	2	3	4	5	6	7	8	9	10	11
Mar., 22	947	962	946	902	894	896	925	979	978	968	950	937	908	940	972	935	938	915	889	926
Apr., 45 val................	1992	2035	1935	1981	1958	1960	1976	1997	2014	1976	1978	1942	1932	1973	2031	2012	1990	1983	1941	1974
May, 39 val................	1811	1812	1798	1778	1776	1759	1779	1804	1816	1812	1795	1781	1784	1798	1825	1842	1836	1789	1798	1811
June, 26 val................	1168	1191	1169	1158	1149	1160	1176	1189	1201	1187	1178	1170	1172	1175	1200	1153	1158	1150	1144	1150
July, 32 val................	1425	1471	1446	1429	1433	1422	1423	1452	1471	1473	1446	1433	1413	1408	1469	1446	1438	1440	1423	1402
Aug., 32 val................	1467	1476	1483	1465	1438	1431	1466	1471	1503	1491	1451	1445	1439	1454	1485	1484	1441	1430	1429	1450
Sept., 37 val................	1739	1750	1757	1721	1704	1721	1723	1800	1787	1749	1735	1721	1673	1715	1769	1783	1746	1741	1703	1686
Oct., 37 val................	1711	1745	1717	1687	1680	1657	1679	1714	1723	1712	1670	1667	1651	1689	1741	1709	1701	1680	1675	1688
Nov., 40 val................	1854	1892	1863	1850	1842	1854	1877	1901	1913	1895	1873	1873	1887	1899	1932	1898	1871	1854	1855	1894
Total, 310 val..............	14114	14334	14164	13971	13874	13860	14024	14307	14406	14163	14076	13969	13859	14057	14424	14262	14119	13982	13857	13981
Weighted mean	455	462	457	451	447	447	452	462	465	457	454	451	447	453	465	460	455	451	447	451
Amplitude × 10/7	458	468	461	452	447	447	454	468	472	461	457	452	447	455	472	465	458	452	447	452

1/6 percent, as given at page 163 of volume 6 of the Annals. But the reader should recall that, on the average, $7/10 \times 310$ days of observation are included in each column of the tabulation giving the weighted general mean. Hence the probable error of a single day is reduced to $1\sqrt{217} = 1/15$ of 1/6 percent for each point in figure 9. Therefore its smoothness is no surprise, despite its small amplitude.

The form of the curve of figure 9 is interesting. There is the rapid rise and slower fall so characteristic of Cepheid variable stars, and of the sunspot curve also. But if we suggest the same cause of variation for the sun as for the Cepheid stars (i.e., expansion and contraction of the orb) I am informed privately by Dr. Merrill of Mount Wilson Observatory that the period of 6.6456 days is not theoretically possible with such a star as the sun. Furthermore the Cepheids are from 100 to 100,000 times as bright as the sun. So, for the moment, we must regard the sun as the *type specimen* of a *new class* of regular variable stars. Stellar photometry does not reach, as yet, I think, accuracy sufficient to enlarge this class to include other objects, for the amplitude of this variation of the sun is only about 1/200 stellar magnitude.

12. ANSWERS TO FOUR INQUIRIES PROPOUNDED UNDER (9)

Answering the four questions proposed above regarding solar variation:

1. The form and amplitude of the mean curve of solar variation in the 6.6456-day period is as given in figure 9.

2. The sun's emission of radiation began to increase on December 31, 1923, not on January 3, 1924, as supposed. It reached maximum on January 3.

3. The solar-constant values are too imperfect and scattering to give directly a satisfactory answer to the question whether different recurrences of the period are of different amplitudes of variation. I shall return to this point below. But it is clear that the large differences of amplitude in terrestrial temperature responses are not paralleled in the solar emission. In proof of this, see figure 10, where are given two curves. One is the mean of the solar-constant changes on 80 recurrences of the period, when large temperature variations were observed. The other curve is the mean of solar-constant changes on 54 occasions when small temperature variations were observed. There is little difference in the amplitudes of the two curves, and indeed the one corresponding to small differences of temperature happens to be of slightly the greater amplitude.

4. The solar changes agree in phases precisely with computed times.

Mean values computed by shifting solar-constant values as temperatures were shifted, as in tables 3 and 4, give less satisfactory curves, and of lower amplitudes, than those computed with exact periodicity, like figure 9. This result is shown graphically in figure 11. The solar-constant values for September are treated with strict periodicity to

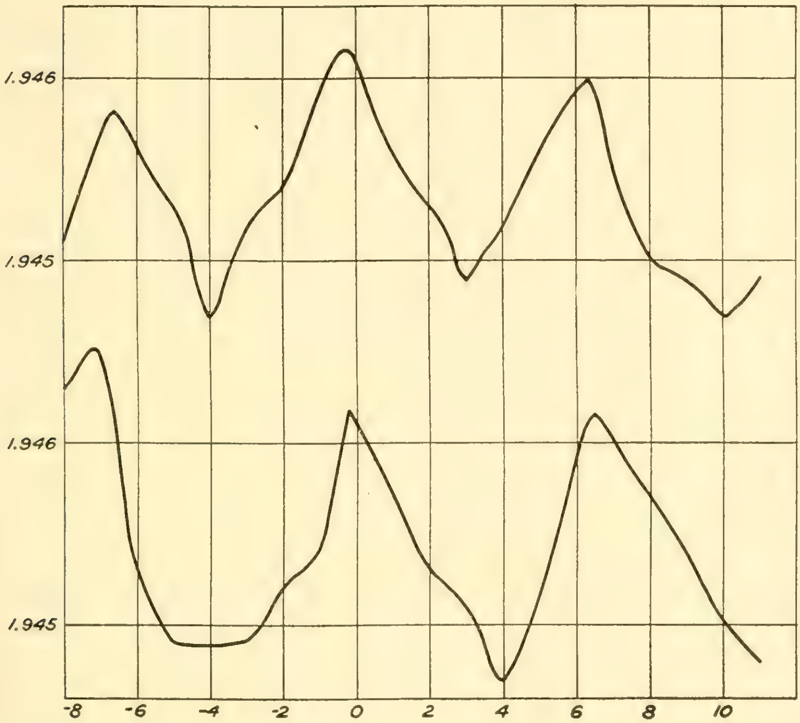


FIG. 10.—Average variation of the solar constant. Upper curve for 80 recurrences of the 6.6456-day period when *large* terrestrial temperature effects at Washington occurred. Lower curve for 56 occasions of *small* terrestrial temperature effects.

derive the upper curve, and with phase shiftings to derive the lower one. Hence the terrestrial shifting of phases is not caused by direct shifting of phases in the solar emission.

13. SPECIAL INVESTIGATION AS TO WHETHER INDIVIDUAL RECURRENCES OF THE 6.6456-DAY PERIOD IN SOLAR VARIATION ARE OF DIFFERENT AMPLITUDES

There remains one other point which I have attempted to clear up. As stated above, the average amplitude of the 6.6456-day period in solar constants is but 0.13 percent. Yet in my two papers of 1936, above cited, the average change of the solar constant used was said to be 0.7 percent. I have remarked above that only the largest solar-constant changes could be discovered individually at that time, and that favorable combinations of them with accidental errors tended to

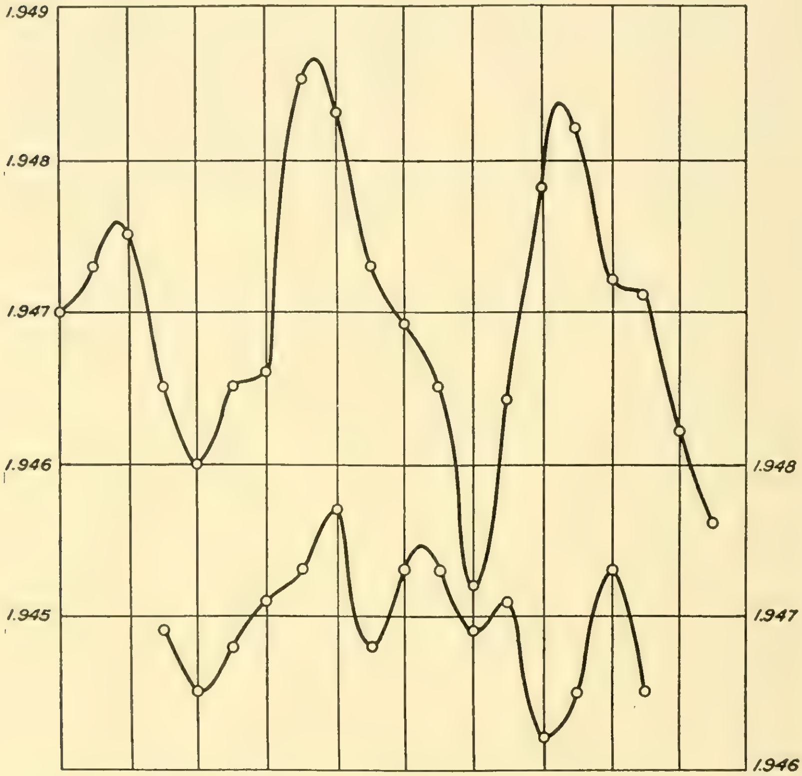


FIG. 11.—Average variations of the solar constant, September observations. In the upper curve no phase shifting is admitted. In the lower curve phase shiftings were made corresponding to phase shiftings at identical times in computing mean values of temperature departures at Washington. Evidently no phase shifting is admissible in solar observations.

give too high an estimate of some of their amplitudes. Having now fixed the phases of the 6.6456-day period, it is possible to pick out from the solar-constant record considerable numbers of cases of small and of large observed change, which were surely real. Such small and large cases could then be averaged separately, in order to find out if the amplitude of the solar changes associated with the 6.6456-day period is really variable. We have already seen that it has no appreciable variability correlated with the temperature effect, if averages of numerous cases are considered.

Employing table 1 of my paper "Weather Predetermined by Solar Variation," above cited, I selected 14 cases of large, and 13 cases of small apparent solar-constant rise, which agreed in phase with the 6.6456-day period, as now settled upon. Unfortunately I could not find any more extreme cases occurring when the records were sufficiently complete to tabulate satisfactorily. The numbers tabulated are far too small, therefore, to yield good curves. Corresponding to all these 27 dates, I had already tabulated the solar-constant values from 8 days before to 11 days after zeroth day. As explained above, I had interpolated such values as were necessary to fill up gaps. I computed separately the mean march of the solar constant for high observed changes, and for low observed changes. The results are as follows:

Days	−8	−7	−6	−5	−4	−3	−2	−1	0	1	2	3	4	5	6	7	8	9	10	11
Mean high values	443	453	427	432	399	396	423	474	464	454	Remainder of curve is too irregular to be useful									
Mean low values	466	468	446	438	444	444	452	478	455	456	447	444	441	462	468	441	445	443	445	445

The amplitude of the curve for high observed solar changes is nearly 0.5 percent, while the amplitude of the curve for low observed solar changes is only about 0.2 percent. Both curves decidedly exceed the amplitude, 0.13 percent, of the mean curve from 310 computed dates, which I give in figure 9. This result, indeed, was to be expected. For the 310 cases no doubt include many cases when the solar-constant change was too small to recognize individually in the incomplete solar-constant record, affected as it is by accidental errors. Had I been able to use all the very highest apparently observed solar-constant changes, many of which I omitted because of too incomplete recording, no doubt the mean result, instead of being 0.5 percent, would have been nearly as large as my estimate of 0.7 percent, made in 1936. But, as stated above, no doubt some of the large apparent changes used in 1936 were made larger by favorable trends of the accidental errors of observations.

It appears from this investigation that the amplitudes of solar variations of 6.6456 days period are indeed variable. Possibly this variation in solar amplitudes may be reflected in the terrestrial temperature responses. Unfortunately the solar-constant record is too imperfect to decide this. Many other observing stations would have to be permanently occupied to determine the solar constant with highest possible accuracy to decide it.

14. IS THE 6.6456-DAY PERIOD USEFUL FOR WEATHER FORECASTING?

I now recur to the question whether the dates of shiftings of phase and variations of amplitude in the temperature curves, such as those shown in figure 3, could be predicted. This is a very important inquiry. For, as just shown, the periodic variations of solar radiation follow an exact time schedule, and doubtless can be computed in phase for many years to come, as well as for many years preceding the year 1923, when our best observations of the solar constant began. Hence, if we could know what allowances to make for phase shiftings, and variations of amplitude, we could predict sun-caused variations of temperature to be expected at Washington and other stations for many years to come, and we could check this method of forecasting against records of many former years.

15. OBSERVED CHANGES OF PHASE AND AMPLITUDE IN TEMPERATURE EFFECTS

I have collected in table 6 the most certain of the data on phase shiftings and variations of amplitude for Washington for all months from the year 1910 to 1945, omitting those occasions for which the curves like those shown in figure 3 were too indefinite to give trustworthy values. I give this table in the hope that meteorologists may use it to discover the key to unlock this puzzle which, if found, would enable them to profit by this proposed new method of moderate-range forecasting.

16. SEARCH FOR CAUSES OF CHANGES IN PHASE AND AMPLITUDE IN TEMPERATURE EFFECTS OF THE 6.6456-DAY PERIOD

I have spent a good many days on this problem myself. It was my first impression that the variations of phase and amplitude were of cosmic causation. I have found no correlation with the sunspot numbers, and only slight ones with the $8\frac{1}{8}$-month, $11\frac{1}{4}$-month, 21-month solar periodicities mentioned on page 181, volume 6 of the Annals of the Smithsonian Astrophysical Observatory, which seemed possible leads. Evidently some more sharply acting variable or variables must govern such isolated, severalfold increases of amplitude as, for instance, from January to February 1937, or from February to March 1943, in Washington.

This consideration leads me to suggest the hypothesis that the terrestrial temperature effects caused by the 6.6456-day solar periodgi

		1910	93
Jan.	S	0.0	4.
	A	4°	8
Feb.	S	0.5	3.
	A	15	
Mar.	S	—1.5	0.
	A	3	
Apr.	S	—3.0	4.
	A	10	
May	S	....	3.
	A	....	
June	S	....	4.
	A	....	
July	S	—1.5	1.
	A	3	
Aug.	S	—2.0	..
	A	2	..
Sept.	S	—2.0	4.
	A	6	
Oct.	S	....	0.
	A	....	
Nov.	S	—4.5	1.
	A	4	
Dec.	S	....	2.
	A	....	

[1] The shift

TABLE 6.—*The best supported cases of phase shifts*[1] *and amplitudes of variation of temperature at Washington. The shifts given in the upper line for each month are in days*

Values: $-\underline{4.0}$, $-\underline{4.5}$, $-\underline{5.0}$, and $-\underline{5.5}$. May be read instead as +2.5, +2.0, +1.5, and +1.0. One cannot know which is correct

		1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Jan	S	0.0	0.5	−3.0	−2.5	$-\underline{4.5}$	−2.0	....	....	....	−1.0	−1.5	0.0	−0.5	−2.5	$-\underline{5.0}$	$-\underline{4.5}$	$-\underline{4.5}$	....
	A	4°	14°	8°	8°	9°	6°	...°	...°	...°	6?°	9°	14°	6°	12°	13°	8°	8°	...°
Feb	S	0.5	−4.0	−2.0	−1.0	....	−2.0	$-\underline{5.5}$	....	$-\underline{4.0}$	....	....	−1.5	−0.5	....	−0.5	−3.5	1.0	−3.0
	A	15	10	6	7	....	3	9	....	9	....	....	9	12	....	4	8	6	6
Mar	S	−1.5			−0.5	....	....	−0.5	....	−2.5	....	−3.5	−1.5	−3.0	0.0	0.5	−3.5	....	$-\underline{4.5}$
	A	3			5	....	....	7	....	8	....	8	18	6	8	6	8	....	5
Apr	S	−3.0	−2.5	−3.5	$-\underline{4.5}$	−2.5	$-\underline{4.0}$	−3.0	$-\underline{4.5}$	−1.5	−0.5	−2.0	−2.0	....	....	$-\underline{5.0}$	−1.5	−3.0	0.0
	A	10	10	4	10	7	8	6.0	8	7	6	8	9	....	....	5	6	14	10
May	S		−0.5			...	....	....	0.0	−1.5	....	....	0.5	....	−2.0	−1.5	$-\underline{5.0}$	−3.0	....
	A		5				..	.	6	7	....	....	9	....	6	5	9	9	....
June	S				−0.5	....	−2.0	−3.0	−2.0	....	−3.5	....	....	0.0	....	....	−3.0	....	−1.5
	A			..	9	....	4	4	4	....	5	....	....	5	....	....	4	....	8
July	S	−1.5	0.0	−1.0	....	−1.5	....	....	0.5	....	....	−3.0	−0.5	−3.5	0.5	$-\underline{4.0}$	−2.5	0.0	....
	A	3	3	3	....	3	....	....	3	....	....	4	3	5	4	4	2	3	....
Aug	S	−2.0	−3.0	−0.5	−3.5	$-\underline{4.0}$	$-\underline{5.0}$	−1.0	0.5	....	$-\underline{4.5}$	−0.5	−2.0	$-\underline{4.5}$	....	....	−3.0	0.0	−3.0
	A	2	[illegible]	4	5	5	6	5	6	....	5	2	5	5	....	....	6	4	2
Sept	S	−2.0			−3.0	....	−3.5	−1.5	−2.5	....	−2.5	....	....	−2.0	....	$-\underline{4.0}$	....	−1.0	....
	A	[illegible]		....	4	....	5	9	8	....	5	....	....	4	....	7	....	4	....
Oct	S		1.0	0.0	−1.0	−2.5	0.5	....	−3.0	....	−3.0	1.0	−3.0	$-\underline{4.0}$	....	−1.5	....	−3.5	....
	A		3	9	6	6	10	....	6	....	7	7	7	8	....	7	....	8	....
Nov	S	$-\underline{1.5}$		−0.5	−1.0	−1.5	−2.0	....	....	....	$-\underline{4.0}$	0.0	$-\underline{5.0}$	−4.5	....	−3.0	−3.5	−2.5	−3.0
	A	4		9	6	7	8	....	....	....	6	5	6	6	....	7	9	10	14
Dec	S			−3.0	....	−1.0	−0.5	−3.5	....	....	$-\underline{4.0}$	$-\underline{4.5}$	−2.0	....	0.5	−2.0	−0.5	0.0	−2.0
	A			4	....	4	4	7	....	....	6	5	12	....	5	8	6	6	9

		1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945
Jan	S	$-\underline{4.0}$	0.0	−3.5	−0.5	$-\underline{4.5}$	−1.0	$-\underline{5.0}$	$-\underline{4.5}$	....	....	−3.0	$-\underline{4.5}$	.	3.5	−3.0	$-\underline{4.5}$	−1.0	...
	A	9°	8°	18°	9°	8°	8°	10°	9°	...°	...°	10°	7°	...°	6°	7°	9°	4°	
Feb	S	$-\underline{4.0}$	−3.0	−1.5	....	−3.0	....	−1.5	$-\underline{1.5}$	−2.5	−5.0	....	−1.0	−3.0	−3.0	....	...	0.5	
	A	12	5	5	....	7	....	7	10	....	9	8	10	....	....	6	....	3	6
Mar	S	....	$-\underline{4.5}$	0.0	$-\underline{5.0}$	−0.5	$-\underline{4.5}$	1.0	$-\underline{4.5}$	−2.5	−1.0	....	−1.5	1.0	−1.5	−2.0	−2.5		
	A	....	7	7	5	7	9	11	5	14	6	....	7	6	8	5	14	.	
Apr	S	0.0	0.0	−1.0	....	$-\underline{4.0}$	$-\underline{3.5}$	$-\underline{4.0}$	−1.5	0.0	−1.0	−1.5	$-\underline{4.0}$	$-\underline{5.0}$	1.5	....	....	−1.5	$-\underline{4.0}$
	A	14	8	8	....	5	9	6	4	5	7	10	6	8	5	....	....	7	6
May	S	....	$-\underline{4.5}$	−2.0	−1.5	−3.0	−3.0	$-\underline{4.0}$	−1.5	$-\underline{5.0}$	....	−3.0	....	$-\underline{4.5}$	$-\underline{5.0}$	....	−1.5	....	$-\underline{5.5}$
	A	....	6	7	8	6	6	6	6	8	....	6	....	12	12	....	8	....	8
June	S	$-\underline{4.5}$	....	....	0.5	$-\underline{4.0}$	2.0	−3.0	....	0.5	−0.5	−3.0	$-\underline{4.5}$	....	−0.5	−2.5	....	....	0.5
	A	8	....	....	7	4	5	4	....	6	4	7	3	....	5	4	....	....	5
July	S	−3.0	....	−2.5	−2.0	−1.5	0.0	−3.0	$-\underline{4.0}$	−1.0	−1.0	−3.0	$-\underline{4.2}$	....	0.5	0.5	....	−0.5	.
	A	2	....	7	7	5	3	5	3	4	5	2	4	....	3	6	....	4	
Aug	S	−1.0	$-\underline{4.5}$	−2.0	....	....	−3.5	−2.0	1.0	−3.0	0.5	−3.5	$-\underline{4.5}$	−2.0	....	$-\underline{5.0}$	−3.0	−3.0	0.0
	A	7	4	2	....	....	3	3	4	5	6	8	3	3	....	7	3	3	4
Sept	S	−3.0	−3.0	−2.0	−0.5	$-\underline{4.5}$	....	$-\underline{5.0}$	−1.5	....	1.0	1.0	−1.0	....	....	1.0	−2.0	−2.5	−3.0
	A	6	8	5	8	5	....	4	8	....	9	6	8	....	....	6	6	3	5
Oct	S	−3.5	−2.0	0.0	−1.5	0.5	....	0.0	−2.5	−2.0	....	0.0	$-\underline{4.5}$	0.5	$-\underline{4.5}$	−2.5	$-\underline{4.0}$	0.0	−1.5
	A	6	10	8	8	5	....	8	4	8	....	4	8	4	9	8	8	9	5
Nov	S	−1.5	....	−2.0	−3.0	−1.5	....	$-\underline{4.5}$	−1.5	$-\underline{5.0}$	0.0	−2.0	....	$-\underline{4.0}$	−1.5	−2.5	−2.0	−0.5	−1.5
	A	4	....	8	8	8	....	7	7	8	6	6	....	5	8	3	7	9	7
Dec	S	−3.0	−1.5	−2.0	−3.5	−2.5	$-\underline{5.0}$	....	....	$-\underline{4.0}$	−0.5	0.5	−1.5	−3.0	−0.5	−1.5	$-\underline{5.0}$	−0.5	$-\underline{5.0}$
	A	5	8	7	8	6	8	....	....	5	7	7	8	4	5	8	7	4	5

[1] The shift numbers given in the table are relative and comparable. They represent, not phase shiftings reckoned from zeroth days, but merely the positions of first maxima, in graphs like fig. 3

icity, since they seem to be too large to be due to direct heating changes (for the solar-constant change, as we have seen, is only 0.13 percent), may be due to such an indirect solar influence as the alteration of the ozone content of the upper air. Theory indicates, and observation confirms, that large percentage fluctuations of the intensity of extreme ultraviolet solar rays occur, and that this produces large fluctuations in atmospheric ozone. Such fluctuations of ozone, operating on the absorption band near 10μ in the infrared spectrum, would alter the earth's cooling to outer space. I have no means at present of testing the ozone hypothesis. It occurred to me, however, that the fluctuations of the critical frequency of ionization, measured in the F_e layer, might give a clue.

17. IONIZATION CRITICAL FREQUENCIES

Dr. Fleming very kindly communicated the hourly F_e values from Huancayo and Watheroo observing stations, 1938 to 1944. I took averages of the daily results for 11 hours of sunlight. These I have averaged by 10-day and monthly intervals for Huancayo. As they may be useful to other investigators, I give them in table 7, which relates only to results from Huancayo.

As it was very clear that both a yearly periodicity, and a sunspot influence occur in these averages, I tabulated them first for the yearly effect, and then, having removed the best average curve of yearly fluctuation, I plotted the residuals against sunspot numbers. Having obtained the best factor of relationship with sunspot numbers of the residuals remaining from yearly corrections, I removed the sunspot effect also, in order to see if there remained some residuals that would show an irregular march, similar to the march of amplitudes of the temperature effects of the 6.6456-day period.

For possible use by other investigators I give the march of the yearly fluctuation of 11-hour daily averages of F_e at Huancayo, Peru, as follows:

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Normal F_e	349	350	346	336	321	310	314	324	332	338	342	347

Also I give the corrections to mean daily (11 daylight hours) F_e values for sunspot numbers:

Sunspot number	5	10	20	30	40	50	60	80	100	120	140	160	180	200
Correction number	−34	−30	−22	−16	−10	−5	+1	12	22	32	42	52	61	71

If the values of normal monthly F_e and the sunspot corrections are both *subtracted* from the mean values of F_e given in table 6, there remain residuals of F_e ranging from -33 to $+38$ critical frequency numbers. I had hoped that these residuals might disclose valuable relationships with the changes of phase and amplitude in the tempera-

TABLE 7.—*Ten-day and monthly means of F_e*

		1938.	1939	1940	1941	1942	1943
Jan.	I	368	367	346	363	337	323
	II	389	373	338	339	336	325
	III	377	366	338	355	328	326
	M	378	369	341	352	333	325
Feb.	I	370	361	342	348	328	328
	II	387	353	347	347	324	331
	III	367	367	342	359	333	330
	M	375	360	344	351	328	330
Mar.	I	372	354	351	352	329	338
	II	387	339	342	343	344	339
	III	371	339	349	326	348	326
	M	376	344	347	340	340	334
Apr.	I	381	334	336	318	314	328
	II	377	342	334	326	325	311
	III	393	353	325	323	330	313
	M	384	343	331	322	323	317
May	I	385	342	309	308	314	303
	II	364	330	317	302	305	294
	III	362	336	313	280	292	284
	M	370	336	313	296	303	294
June	I	361	328	314	298	297	289
	II	341	324	309	290	303	285
	III	324	332	310	293	290	284
	M	342	328	311	293	296	286
July	I	337	340	312	301	297	283
	II	344	333	315	294	302	289
	III	345	329	314	318	301	289
	M	342	334	313	304	300	287
Aug.	I	351	340	328	314	298	288
	II	348	347	342	323	300	293
	III	349	348	339	316	307	300
	M	349	345	336	318	302	293
Sept.	I	355	367	341	311	306	297
	II	342	356	344	332	311	301
	III	365	375	349	331	318	299
	M	354	366	344	325	312	299
Oct.	I	360	363	355	332	318	301
	II	359	359	356	333	323	303
	III	364	361	348	326	320	306
	M	361	361	353	330	320	304
Nov.	I	365	347	366	329	331	306
	II	370	353	360	324	323	319
	III	376	356	352	344	331	319
	M	370	352	359	332	328	314
Dec.	I	383	343	353	336	337	321
	II	377	353	369	335	320	422
	III	367	343	350	333	331	324
	M	375	346	357	334	329	322

ture departures, associated with the 6.6456-day solar period. But they do not. They do give a small positive correlation coefficient with monthly solar constant numbers, but it is hardly large enough to be significant.

I have also compared the 10-day and monthly sunspot numbers directly with the fluctuations of phases and amplitudes of the temperature effects, associated with the 6.6456-day solar period. But I do not find any significant correlations.

18. POSSIBLE TERRESTRIAL CAUSATION OF THE CHANGES IN PHASES AND AMPLITUDES OF THE TEMPERATURE RESPONSE TO THE 6.456-DAY SOLAR PERIODICITY

Having been unable to connect these fluctuations of phase and amplitude in temperature effects of the 6.6456 periodicity with any cosmic causation, I can only hope that meteorologists may be able to connect them with features of the atmospheric circulation. For I repeat what I said above. The dates of solar change may be accurately predicted. As yet the amplitudes of the periodic solar changes cannot be individually measured with accuracy, and there is as yet no apparent correlation of the temperature effects on the earth with corresponding changes in the sun.

The terrestrial temperature effects are very large. In their average dates of recurrence they obey the period 6.6456 days perfectly. Unfortunately, though the four or five recurrences of a single month are usually separated almost exactly by 6.6456-day intervals, they all may be shifted from 1 to 3 days with respect to recurrences in other months. The amplitudes of the individual recurrences within a single month differ, but rarely differ to a very great extent. But from one month to another, or from one year to another, they may differ by even as much as tenfold.

19. DATA FOR METEOROLOGISTS

If the variations of phases and amplitudes could be predicted, this large hitherto unused weather element might be of great value to forecasters. In order that meteorologists may have data to work with, if they should try to solve the enigma of the fluctuations of phases and amplitudes, I have given in table 6 (ante) a selection of the best supported cases of the shiftings of phase, and of the varying amplitudes, assumed by the temperature effects of the 6.6456-day period at Washington, from the year 1910 to 1945. The vacancies in the table correspond to occasions when the curves I have prepared, similar to figure 3, were too indefinite in their marches to give trustworthy values of the phase shiftings or the amplitudes. It may generally be assumed, however, that on these occasions the amplitudes were small.

In further collection of information which may assist meteorologists to search for the causes of fluctuations of phase and amplitude, I have selected 12 occasions when, at Washington, there was a large difference in amplitude between temperature effects in one month and the next. For each case I have determined the change of amplitude at St. Louis and Helena. In the hope that these may be of value to compare with the prevailing circulation of the atmosphere on these occasions, I give these data in table 8. The figures are the amplitudes, in degrees Fahrenheit, of the average temperature effects of the 6.6456-day cycle, in the months specified in the first and second columns of table 8.

TABLE 8.—*Amplitudes of temperature effects of 6.6456-day cycle, contrasting months, remote stations*

Year	Couple	Washington	St. Louis	Helena
1924	Jan./Feb.	12.5/6.0	12.0/6.5	9.0/5.0
1925	Oct./Nov.	3.5/8.7	4.7/12.3	9.5/9.0
1926	Mar./Apr.	3.5/14.7	8.5/9.0	4.0/2.0
1927	Oct./Nov.	4.0/16.0	6.3/13.3	4.7/10.3
1928	Feb./Mar.	11.0/5.0	7.5/5.0	7.0/3.0
1928	Mar./Apr.	5.0/11.0	5.0/12.5	3.0/5.0
1929	Oct./Nov.	9.7/8.3	4.7/9.5	7.5/9.3
1930	Jan./Feb.	18.0/6.7	14.0/10.7	7.0/5.3
1931	Jan./Feb.	6.7/3.0	10.0/6.5	7.7/9.0
1936	Feb./Mar.	4.0/13.3	8.5/10.7	9.5/10.0
1939	Jan./Feb.	6.7/12.3	7.3/11.3	3.0/17.3
1943	Feb./Mar.	6.3/13.3	10.0/10.0	12.0/6.3

Total No. couples	12
All agree in trend	7
Washington-Helena agree	7
Washington-St. Louis agree	10
St. Louis-Helena agree	9

20. A TRIAL FORECAST A MONTH IN ADVANCE OF WASHINGTON TEMPERATURE DEPARTURES WITH VERIFICATION

Although no means have been found as yet of predicting shiftings of phase, and changes of amplitude, of the temperature effects attending the 6.6456-day period, the fact that a month or more frequently elapses without much change in these respects, encouraged me to make a trial forecast of Washington temperature departures based on this periodicity.

I took the expected amplitude from the first two recurrences of the period computed for October 1931, as plotted in figure 3. The phase is unchanged throughout from that of early October. These data on amplitudes really involve all the days from September 27 to November 1, but in different proportions. Six-tenths of the weight of the determination rests on the data of September 27 to October 16. Ac-

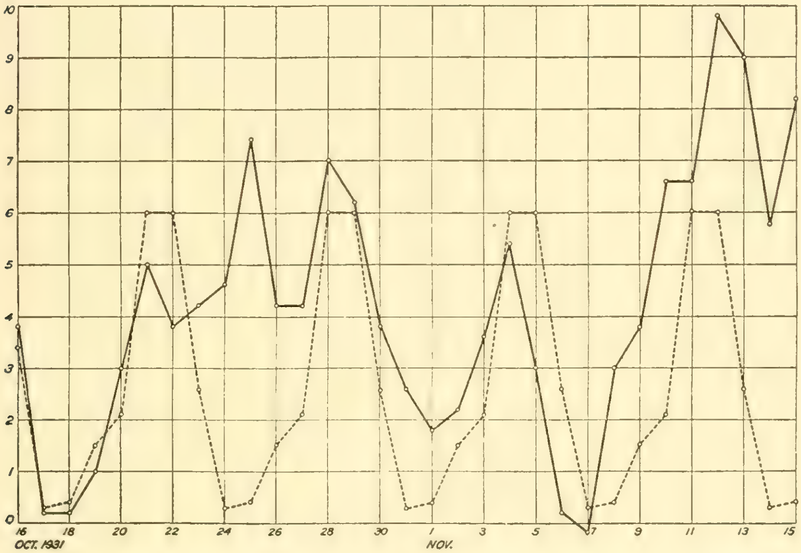


FIG. 12.—Thirty-six-day prediction of temperature departures at Washington, based on previous phases and amplitudes of the 6.6456-day period. Dotted curve forecast, full curve the event, reduced by the factor 4/10. Arbitrary zero of ordinates.

cordingly my prediction from October 16 to November 18 is *to a slight degree* governed as to amplitudes, *not at all as to phases,* by what actually occurred as late as November 1, but beyond that date it is pure prediction in all respects.

I give in table 9 all the numerical figures used in preparing the forecast from the data plotted in figure 3, as above specified. It will be seen how little work is involved. Figure 12 gives the forecast and verification. The full curve is the graph of the actual departures from normal temperature at Washington, as published by the United States Weather Bureau, but reduced in scale by multiplying by the factor 4/10. The dotted curve shows the forecast of the departures caused by the 6.6456-day periodicity, expressed in degrees Fahrenheit. The prediction is based to give temperatures all above the zero, and the scale of ordinates in figure 12 starts from zero, although the zero of observed temperatures is at $+3°$. Hence in the comparison between prediction and event, given at the bottom of table 9, a scale-correction of 3° F. has to be made, as indicated in column 1 of table 9.

Readers will observe that maxima and minima agree well. The average deviation in the curves, as plotted, between prediction and event for 36 days is 2.6 degrees F. But the factor 4/10 having been applied to the actual temperature departures, the true average deviation is 6°.5 F. It is largely made up by the sporadic discordances of October 24-25, and by the excessive temperature departures of November 13-18. This latter discrepancy comes, of course, from the assumption made that within the interval of 36 days there would be no change in the amplitude of the 6.6456-day periodicity. It failed after 22 days. If one omits 7 days of large discrepancy, the average deviation for the remaining 29 days is 1°.7 on the graph, or 4°.2 in reality. I presume meteorologists would hardly expect to make much smaller averages of deviations in forecasting for 1 or 2 days in advance.

21. SUMMARY

Extension of tabulations published in 1936 having shown the probable existence of a period of about $6\frac{2}{3}$ days in solar variation, this assumed period was traced in Washington temperatures from 1910 to 1945, and found to prevail with the exact average period of 6.6456 days.

Shiftings of phase rarely occur in the recurrence of temperature effects of this cycle within a single month, but in different months and years phase shiftings of plus and minus 1, 2, and 3 days occur.

The amplitudes of the temperature effect change moderately in the several recurrences of the period within a month, but from month to month the changes of amplitude are sometimes large. The range of amplitudes for months of the same name but in different years, is from 2° F. to 20° F. The average amplitude, 1910 to 1945, for all months, is about 5° F. For summer months less, for other months more.

Tabulations of values of the solar constant of radiation of the years 1924 to 1944 were made to fix the form, amplitude, and phase of the curve of variation of solar radiation in the period of 6.6456 days.

The form of the average solar curve shows an abrupt rise and slower fall. The phase is such as to give maximum radiation on January 3, 1924. The average amplitude, corrected by a factor of 10/7 for influence of supplying by interpolation of days missing in the record, is 0.13 percent of the solar constant of radiation. This is

TABLE 9.—*Prediction trial*

1931
October I and II used to predict from

	—4	—3	—2	—1	0	1	2													
1st period	2°8	0°8	2°2	6°8	4°8	2°8	2°4													
2nd period	1.6	0.8	4.4	9.2	2.0	—2.2	—1.6													
Mean	2.2	0.8	3.3	8.0	3.4	0.3	0.4													
Dates				Oct.	16	17	18	19[1]	20	21	22	23	24	25	26	27	28	29	30	31
Forecast					+3°4	0°3	0°4	1°5	2°1	6°0	6°0	1°8	0°3							
												3.4	0.3	0°4	1°5	2°1	6°0	6°0	1°8	0°3
												Mean 2.6	0.3							
			Nov.																	
Dates	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Forecast	+3°4	0°3	0°4	1°5	2°1	6°0	6°0	1°8	0°3											
	1.8	0.3						3.4	0.3	0°4	1°5	2°1	6°0	6°0	1°8	0°3				
	Mean 2.6	0.3						Mean 2.6	0.3						3.4	0.3	0°4	1°5	2°1	6°0
															Mean 2.6	0.3				
4/10					0°8	—2°8	—2°8	—2°0	0°0	2°0	0°8	1°2	1°6	4°4	1°2	1°2	4°0	3°2	0°8	—0°4
Actual departures	+0°8	—0°4	—1°2	—0°8	0.0	2.4	0.0	—2.8	—3.2	0.0	0.8	3.6	3.6	6.8	6.0	2.8	5.2	6.8	3.2	10.4
4/10 actual +3° minus					0°4	—0°1	—0°2	—0°5	0°9	—1°0	—2°2	1°6	4°3	7°0	2°7	2°1	1°0	0°2	2°0	2°3
Forecast	1°2	2°3	1°4	0°7	0°9	—0°6	—3°0	—2°4	—0°5	2°6	2°3	4°5	0°6	3°8	6°4	5°5	7°8	8°3	4°1	7°4

[1] The last six values in each cycle are those interpolated from the values marked "mean" to suit the fractional days due to the length of the cycle being 6.6456 days. Thus 1°5 on October 19 $\frac{2°2+0°8}{2}$.

the mean of 310 recurrences in the months March to November. The remaining over 800 recurrences had to be omitted because of lacunae in the record.

Tabulations were made of solar-constant data under two assumptions: First, that the phase of the periodicity remained unchanged in the solar emission; second, that the solar phases shifted in the same way that the phase of terrestrial temperature effects shifts. The first hypothesis proved correct. There is no shifting of the phase in the sun, and the dates of recurrence of the period in solar radiation may be predicted indefinitely.

Tabulations were made of solar-constant data in two groups. One group included only months when the temperature effect was of great amplitude, the other group the opposite. No appreciable difference was found in the two averages of solar change.

The average amplitude of the solar change is so surprisingly small, compared to the 0.7 percent estimated in 1936, that two tabulations were made for occasions when changes of the solar constant had been individually recorded with tolerable completeness. One group contains only large, the other only small, observed solar changes. There was a decided difference in the two averages of results. The high group average was about 0.5, the low group average about 0.2 percent. It is believed that the solar changes attending the periodicity range in reality from zero to 1 percent or more. The unselected group of 310 solar-constant values, giving 0.13 percent range in amplitude, doubtless contains a majority of solar changes too small to observe with certainty separately in the record.

The average amplitude of solar change is so small, compared to the average amplitude of temperature change associated with the 6.6456-day periodicity, that one is inclined to attribute the terrestrial temperature effect to some indirect action, rather than to direct heat effects of change in the insolation. Such an indirect action may be produced by large percentage changes in extreme ultraviolet solar radiation, producing large percentage fluctuations of atmospheric ozone, and large changes of absorption by ozone in outgoing earth rays, at about 10 microns wave length. I have not been able to test this hypothesis.

Attempts were made to discover correlations between the amplitudes of terresterial heat effects of the cycle and several known cosmic fluctuations, but without success. Tabulations are given of changes in phase and amplitude of temperature effects in Washington, St. Louis, and Helena, in the hope that meteorologists may thereby discover correlations with atmospheric circulation, which may enable them to tell in advance when such changes of phase and of amplitude will occur. If such changes could be forecasted, then, as the dates of recurrence of the sun's changes can be predicted indefinitely, very long-range weather forecasts might perhaps be made.

It is pointed out that temperature forecasts of the order of a month in advance may perhaps even now be practicable with the aid of this new cycle. For, as stated, the phases of recurrence of temperature effects almost always remain nearly unchanged in any one month, and the variation of amplitude is not often excessive within that interval. Hence with a continuously kept running curve of the temperature effect, similar to figures 2 and 3, predictions might be hazarded with considerable confidence for a month in advance. A preliminary trial forecast for 36 days was made, and gives an average deviation of 6°.5 F. from the event. Omitting 7 days of sporadically wide discrepancies and of obviously increased amplitude of the temperature periodicity, 23 days after the forecast began, the remaining 29 days give an average deviation from the event of 4°.2 F.

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(With Four Plates)

BY
RICHARD E. BLACKWELDER
Associate Curator, Division of Insects
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(Publication 3894)

CITY OF WASHINGTON
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PART I. NOMENCLATURE CHANGES

The discovery of the oldest genotype designation for each generic name is one of the important procedures in the stabilization of nomenclature. Accurate information on the status of the older works in which designations were made is therefore very desirable. The discovery of some pertinent facts about one of these source works in entomology has prompted the publication of this analysis.

On January 1, 1824, John Curtis commenced the publication in London of a major work entitled "British Entomology; being illustrations and descriptions of the genera of insects found in Great Britain and Ireland: containing coloured figures from nature of the most rare and beautiful species, and in many instances of the plants upon which they are found." In this work he proposed to illustrate by means of a colored plate and drawings of certain structures each of the genera of insects known from the British Isles. These illustrations were frequently, but by no means always, made from the species which Curtis listed as the type of that genus, but it is this designation of a type species for each genus which gives the work most of its interest today.

It was proposed to publish the plates in 16 volumes of 12 parts each, or 770 plates in 192 parts. One part of four (or at first five) plates was to be issued every month starting in January 1824. This plan was rigidly adhered to, and the publication schedule was apparently met without exception.

After 5 years of publication, Curtis apparently found his edition too small to supply the demand. He therefore began to reprint the previous parts, eventually covering parts 1 to 30. The existence of this second printing was noted in the Zoological Journal, volume 4, pages 494-496 (January–May 1829), by Percheron in 1837, and in the bibliographies of Hagen and of Horn and Schenkling, but no information was given on the dates of publication or the accuracy of the resetting. In 1911 Sherborn and Durrant published an analysis of the dates of publication of these reprinted parts. These authors comment on the contents of the reprints as follows: "Parts one to eight were rewritten and enlarged, some from two to ten pages, with alterations of nomenclature and additions; parts nine to thirty were reset and reprinted without alteration or addition; and parts 31 to 192 were all of the first edition, i.e., one setting and one printing." Three cases of changes of name, one case of additions to a plate itself, and one of increased text are cited in addition.

Messrs. Sherborn and Durrant either failed to notice or did not attach any importance to the facts that in three cases the genotype designation was changed and that major nomenclatural revisions occurred in five other cases. The realization of this makes the recognition of the reprinted plates of great importance, since nearly all sets of this work contain the reprints mixed in with the original edition.

The recognition of the edition of certain parts and certain plates can be made by means of "clues" listed by Sherborn and Durrant. I believe that if these writers had attached more importance to the identification of these editions they would have recorded more universal recognition characters.

The present writer is fortunate to have at his attention one set of the original edition bound in 16 volumes as published, in numerical order, and one set bound in 8 volumes in systematic order, containing all the reprinted pages.[1] The first of these is in the library of the United States Department of Agriculture, Washington, D. C.; the second is in the entomology section of the library of the United States National Museum, Washington, D. C.

Comparison of these two sets page by page reveals many interesting points. First, in every case except the text of plate 30 and those plates after 34, the second edition can be at once identified by the addition of an underscoring line beneath the plate number on the text and the plate. Plate 30 can be recognized by the addition of the systematic serial number 283 to the text and plate and the underscore on the plate.

The dates given on the original plates are believed to be entirely accurate, but the reprinted plates have the same dates as the originals, which is obviously erroneous. Any plate with the plate number (at top) underscored is a reprint and its actual date of publication is much later than shown.

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[1] Three other sets have been examined in detail, as described in part II of this paper.

Sherborn and Durrant estimate the dates of publication of the first eight parts of the second edition. I have found nothing to change their conclusions except that part 1 may have appeared in 1828 (see Zoological Journal, vol. 4, pp. 494-496, January–May 1829, in which completion of volume IV (in 1827) is noted). It seems best to adopt January 1, 1829, as the date of this part. These parts may be dated as follows:

Part No.	Plates included	Date
1	1-5	1829 (January 1)
2	6-10	1830 (after July)
3	11-14	1834
4	15-18	1835
5	19-22	1835
6	23-26	1839
7	27-30	1840
8	31-34	1840

It does not seem to be worth while to list all the changes that have been found on each plate and page of text, but facsimiles have been prepared of all the pages wherein nomenclatural changes occur, and the other cases will be mentioned briefly in systematic rather than numerical order.

COLEOPTERA

Cicindelidae. Genus *Cicindela* Linn. Plate 1 (No. 1 of volume I of the systematic arrangement; reprinted in 1829). Text enlarged to four pages, with additional species mentioned.

Carabidae. Genus *Nebria* Latr. Plate 6 (No. 6 of volume I of the systematic arrangement; reprinted in 1830). Additions to plate; text rewritten, with additional species mentioned.

Carabidae. Genus *Omaseus* Ziegler. Plate 15 (No. 22 of volume I of the systematic arrangement; reprinted in 1835). Additions to plate; text rewritten and enlarged to four pages, with changes in the generic synonymy, and additional species mentioned.

[Dytiscidae. *Acilius* Leach. In the Zoological Journal, volume 3, pages 139-140 (January 1827) appears the following in reference to volume II: "An additional leaf is given in the last number for the purpose of being substituted for that containing the description of *Acilius cinereus*, the insect previously figured under this name being in fact a new species, to which Mr. Curtis has found it necessary to assign the name *A. caliginosus*." The date of this new sheet (letter-press only) is December 1825, although the date of plate 63 and the original sheet (*Acilius cinereus*) was April 1825.]

Staphylinidae. Genus *Siagonum* Kirby. Plate 23 (No. 117 of volume I of the systematic arrangement; reprinted in 1839). Slight changes to the plate;[2] text rewritten with additions, and generic name emended. (See facsimiles, figs. 1, 2.)

Buprestidae. Genus *Buprestis* Linn. Plate 31 (No. 51 of volume II of the systematic arrangement; reprinted in 1840). Text rewritten and enlarged, with new synonymy and additional species mentioned.

Rhipiphoridae. Genus *Rhipiphorus* Fabr. Plate 19 (No. 22 of volume II of the systematic arrangement; reprinted in 1835). Additions to plate; text rewritten and enlarged, with the generic name emended.

Scarabaeidae. Genus *Aphodius* Illiger. Plate 27 (No. 70 of volume I of the systematic arrangement; reprinted in 1840). Text rewritten, with additional species mentioned.

Cerambycidae. Genus *Molorchus* Fabr. Plate 11 (No. 106 of volume II of the systematic arrangement; reprinted in 1834). Text rewritten and enlarged, with generic name changed and the synonymy reversed. (See facsimiles, figs. 3, 4.)

Chrysomelidae. Genus *Cryptocephalus* Geoff. Plate 36 (No. 120 of volume II of the systematic arrangement; reprinted in 1840). Reset without change.

HYMENOPTERA

Xiphydriadae. Genus *Xyela* Dalman. Plate 30 (No. 27 of volume III of the systematic arrangement; reprinted in 1840). Text revised slightly, with additional generic synonymy.

Tenthredinidae. Genus *Croesus* Leach. Plate 17 (No. 23 of volume III of the systematic arrangement; reprinted in 1835). Text rewritten and enlarged, with additional species mentioned.

Ichneumonidae. Genus *Peltastes* Illiger. Plate 4 (No. 45 of volume III of the systematic arrangement; reprinted in 1829). Some retouching on the plate; text enlarged with the specific name of the type species replaced by a synonym. (See facsimiles, figs. 5, 6.)

Diplolepidae. Genus *Ibalia* Latr. Plate 22 (No. 63 of volume III of the systematic arrangement; reprinted in 1835). Slight changes to the plate; text changed slightly and with generic synonymy added.

Chrysididae. Genus *Chrysis* Linn. Plate 8 (No. 3 of volume IV of the systematic arrangement; reprinted in 1830). Text rewritten and enlarged to six pages, with additional synonymy and species.

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[2] Reproductions of the plates are at the end of the paper. They may be identified by their original plate numbers.

Vespidae. Genus *Eumenes* Fabr. Plate 13 (No. 27 of volume IV of the systematic arrangement; reprinted in 1834). Additions to the plate; text rewritten and enlarged.

Larridae. Genus *Psen* Latr. Plate 25 (No. 23 of volume IV of the systematic arrangement; reprinted in 1839). Additions to the plate; text rewritten and enlarged, with change of genotype, addition of synonymy, and additional species mentioned. (See facsimiles, figs. 7, 8.)

LEPIDOPTERA

Papilionidae. Genus *Lycaena* Fabr. Plate 12 (No. 15 of volume V of the systematic arrangement; reprinted in 1834). Slight changes to the plate; text enlarged to 10 pages, with additional synonymy.

Sphingidae. Genus *Deilephila* Ochs. Plate 3 (No. 21 of volume V of the systematic arrangement; reprinted in 1829). Additions to the plate; text rewritten, with additional synonymy.

Arctiidae. Genus *Eyprepia* Ochs. Plate 21 (No. 49 of volume V of the systematic arrangement; reprinted in 1835). Text rewritten, with additional synonymy and species.

Phalaenidae. Genus *Bupalus* Curtis. Plate 33 (No. 6 of volume VI of the systematic arrangement; reprinted in 1840). Text rewritten, with additional synonymy and species.

Bombycidae. Genus *Dendrolimus* Germar. Plate 7 (No. 41 of volume V of the systematic arrangement; reprinted in 1830). Additions to the plate;[2] text rewritten with the generic name emended and synonymy added. (This is the most complicated change in any of the genera; facsimiles are given of the first page of each edition and of the new genus. Figs. 9, 10, 11.)

Tortricidae. Genus *Peronea* Curtis. Plate 16 (No. 50 of volume VI of the systematic arrangement; reprinted in 1835). Slight changes to the plate; text rewritten and enlarged to eight pages, with additional synonymy.

Tortricidae. Genus *Sarrothripus* Curtis. Plate 29 (No. 51 of volume VI of the systematic arrangement; reprinted in 1840). Additions to the plate; text rewritten, with additional synonymy and species.

Tortricidae. Genus *Gastropacha* Ochs. Plate 24 (No. 42 of volume V of the systematic arrangement; reprinted in 1839). Text slightly rewritten.

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[2] Reproductions of the plates are at the end of the paper. They may be identified by their original plate numbers.

HEMIPTERA

Pentatomidae. Genus *Pentatoma* Olivier. Plate 20 (No. 51 of volume VII of the systematic arrangement; reprinted in 1835). Text rewritten and enlarged, with the British species arranged in Hahn's "new genera" (which are not adopted).

Pentatomidae. Genus *Acanthosoma* "nob." Plate 28 (No. 50 of volume VII of the systematic arrangement; reprinted in 1840). Text revised and enlarged, with additional synonymy and species.

Hydrometridae. Genus *Velia* Latr. Plate 2 (No. 26 of volume VII of the systematic arrangement; reprinted in 1829). Additions to the plate; text revised and enlarged, with additional species mentioned.

Hydrometridae. Genus *Hydrometra* Latr. Plate 32 (No. 28 of volume VII of the systematic arrangement; reprinted in 1840). Text revised and enlarged, with additional species mentioned.

Notonectidae. Genus *Notonecta* Linn. Plate 10 (No. 22 of volume VII of the systematic arrangement; reprinted in 1830). Text revised and enlarged, with additional species mentioned.

DIPTERA

Tipulidae. Genus *Ctenophora* Meigen. Plate 5 (No. 12 of volume VIII of the systematic arrangement; reprinted in 1829). Additions to the plate; text revised and enlarged, with additional synonymy and species.

Rhagionidae. Genus *Atherix* Meigen. Plate 26 (No. 31 of volume VIII of the systematic arrangement; reprinted in 1839). Text revised, with additional synonymy and species.

Anthracidae. Genus *Anthrax* Scopoli. Plate 9 (No. 32 of volume VIII of the systematic arrangement; reprinted in 1830). Text revised and enlarged to four pages, with additional species mentioned and the genotype changed. (See facsimiles, figs. 12, 13.)

Empididae. Genus *Empis* Linn. Plate 18 (No. 40 of volume VIII of the systematic arrangement; reprinted in 1835). Additions to the plate; text revised and enlarged, with additional species mentioned.

Syrphidae. Genus *Milesia* Fabr. Plate 34 (No. 57 of volume VIII of the systematic arrangement; reprinted in 1840). Text revised and enlarged with additional generic synonymy.

Hippoboscidae. Genus *Haemobora* "nob." Plate 14 (No. 105 of volume VIII of the systematic arrangement; reprinted in 1834). Text rewritten, with the new names now credited to Curtis. (See facsimiles, figs. 14, 15.)

Facsimiles

23.

SIAGONUM QUADRICORNE.

ORDER Coleoptera. FAM. Staphylinidæ *Lat., Leach.*

Type of the Genus S. quadricorne *K.*

SIAGONUM *Kirby Introduction to Entomology.*

Antennæ half the length of the insect, pubescent and hirsute, straight, articulated; gradually increasing in size from the second joint (which is smaller than the first) to the extremity; terminal joint obovate. (f. 6.)

Labrum exserted, transverse, bilobed, ciliated. (1.)

Mandibles of male much longer than the head, produced externally far beyond the apex, which has the appearance only of a strong tooth, ciliated internally (2.): of female, broad at their base, hooked, very slightly produced externally. (2. a.)

Maxillæ divided internally, ciliated; terminal process dilated, rounded, composed of parallel, transverse ribs, detached at the apex: *Palpi* 4-jointed, first joint small, last cylindric-ovate, terminated by a globular gland. (3.)

Mentum transverse, broadest at the base, lobed in the centre behind, and obtusely pointed before: *Palpi* appearing 4-jointed, all the joints corneous only at the base, last joint the longest.

Lip dilated anteriorly, bilobed, ciliated. (4.)

Head *not broader than thorax, with a horn on each side before the eyes in the males (vide the coloured figure): females without horns (fig. 7.).* Thorax *narrowed behind.* Elytra *longer than broad.* Abdomen *linear, 6- and 7-jointed.* Legs *very short and small.* Tibiæ *ciliated internally, and serrated (except in the last pair) externally, spined.* Tarsi *5-jointed, last joint equal in length to the other four (5. a fore-leg).* Wings *long, broad, transparent, with only 3 short nerves at the base.*

QUADRICORNE *Pl. 1. f. 3. Kirby and Spence's Int. to Ent.*

Depressed, shining, punctured; antennæ and abdomen pilose. Head nearly black. Horns, mandibles, antennæ and legs reddish brown. Thorax deep chesnut, quadrate, narrow behind; anterior margin rather convex in the centre, angles slightly produced, rounded, with a smooth line of colour down the centre. Elytra chesnut colour, brightest towards the centre, with 2 branched and 2 simple-punctured striæ on each. Abdomen blackish, with the edges of the segments reddish brown.

In the Cabinets of Mr. Kirby, Dr. Stephenson, and the Author.

A FIGURE of *Siagonum quadricorne* was given in the 1st vol. of the Introduction to Entomology by Mr. Kirby, who took a

FIG. 1.—Facsimile of page from first edition.

23.

SIAGONIUM QUADRICORNE.

ORDER Coleoptera. FAM. Staphylinidæ *Lat.*

Type of the Genus, S. quadricorne *Kirb.*

SIAGONIUM *Kirb.*, *Curt.*—Prognathus *Lat.*

Antennæ inserted in a cavity before the eyes, long, straight and hairy, 11-jointed, basal joint rather the longest, 2nd nearly as long as the 3rd, both pear-shaped, the remainder ovate-truncate; apical joint rather longer than the 10th, the apex conical (6).

Labrum exserted, transverse, deeply emarginate, bilobed, ciliated (1).

Mandibles projecting beyond the head in the male, the apex forming a long curved claw, a short strong curved tooth on the inside at the centre, ciliated beneath (2): elongate-trigonate in the female, the apex hooked, with a shoulder outside towards the apex, ciliated internally (2 ♀).

Maxillæ with a long ciliated internal lobe; terminal one ovate, dilated, striated transversely, ciliated. *Palpi* longish, 4-jointed, basal joint small, 3rd short, 2nd and 4th the longest, the latter fusiform-truncate (3).

Mentum transverse, lobed at the base, obtusely trigonate before. *Lip* broad, cordiform, ciliated. *Palpi* shortish, apparently 4-jointed, joints subquadrate, 4th longer ovate (4).

Head *as broad as the thorax, with a strong conical horn on each side in the males, before the* eyes *which are small and globose; orbicular and unarmed in the female* (7). Thorax *depressed, semiorbicular, narrowed at the base:* scutel *triangular.* Elytra *oblong, longer than the thorax.* Wings *very ample.* Abdomen *long linear and marginate.* Legs *very short and small:* thighs *stoutish:* tibiæ *spurred,* 4 *anterior, ciliated internally and serrated externally:* tarsi *longish, very slender and clavate,* 5*-jointed, first* 4 *joints very short,* 5*th equal in length to the others united:* claws *long and slender* (5, *a fore leg*.).

Larva *narrow, with distinct antennæ,* 6 *pectoral feet and* 2 *anal appendages.* Zool. Journ. v. 3. pl. 2. f. 1.

QUADRICORNE *Kirb.*—*Curt. Guide, Gen.* 213. 1.—rufipennis *Blond. Guer.* Depressed, shining, punctured; antennæ and abdomen pilose: head nearly black: horns, mandibles, antennæ and legs reddish-brown: thorax deep chestnut, with a smooth line of colour down the centre; anterior margin rather convex in the centre, angles slightly produced and rounded. Elytra chestnut-colour, brightest towards the centre, with 2 branched and 2 simple-punctured striæ on each: abdomen blackish, with the edges of the segments reddish brown.

In the Author's and other Cabinets.

FIFTEEN years have elapsed since this genus first appeared in the present work, when accidentally the generic name was incorrectly spelt,

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FIG. 2.—Facsimile of page from second edition.

11.

MOLORCHUS MINOR.

ORDER Coleoptera. FAM. Cerambycidæ *Lat.*
Type of the Genus Necydalis Umbellatarum *Linn.*

MOLORCHUS *Fab.* Necydalis *Linn., Lat.*

Antennæ inserted in a notch in the eyes, somewhat setaceous, varying in length, first joint thick, second very small, third and following long, cylindric and rather clavate.

Labrum very minute, hairy and dilated very much in front, cordiform. (1.)

Mandibles short, triangular, slightly hooked. (2.)

Maxillæ crustaceous at the base, with 2 coriaceous lobes, the external one the largest, regularly ciliated. (3. a.) *Palpi* 2, the first 3 joints small, the last thick, ovoid, compressed and truncated. (3. b.)

Mentum broad, convex at the sides, emarginate before. (4. a.) *Lip* coriaceous, 2-lobed. (4. b.) *Palpi* 2, inserted before the lip, short, 3-jointed, formed like the others. (4. c.)

Head *sloped off before.* Thorax *without spines, nearly orbicular.* Body *elongate, narrow, subcylindric.* Elytra *abbreviated, gaping at the apex.* Wings *longer than abdomen, not concealed, but folded upon and covering the abdomen when at rest.* Anterior legs *shortest,* posterior *longest; thighs very much clavate.* Tarsi *4-jointed, spongy beneath, the third joint deeply divided, the last rather long, terminated by* 2 *claws.* (5. *a fore-leg.*)

M. MINOR *Linn. Syst. Nat.* 2. 641. 2.
M. dimidiata *Fab. Ent. Syst. t.* 1. *pars* 2. *p.* 357. 3.

Black, shining, pubescent. Head and thorax minutely punctured, the latter cylindric, oval-truncate, having 2 longitudinal shining lines near the centre. Elytra dark chesnut, with an oblique light spot upon each: the tips thicker and darker. Wings fuscous. Antennæ ferruginous. Legs bright chesnut, the thighs clavate towards the joint and black. Tibiæ hairy.

In the Cabinet of the Author.

THE genus *Necydalis* of Latreille ought probably to be divided: I have therefore adopted Fabricius's generic name for the

FIG. 3.—Facsimile of page from first edition.

11.

NECYDALIS MINOR.

ORDER Coleoptera. FAM. Cerambycidæ.

Type of the Genus, Necydalis Umbellatarum *Linn.*

NECYDALIS *Linn., Oliv., Mars., Lat.*—Molorchus *Fab., Gyl., Curt.*—Gymnopterion *Schr.*?

Antennæ inserted in a notch in the eyes on each side the crown of the head, slightly setaceous, pubescent and having a few hairs beneath except towards the apex, 12-jointed and much longer than the insect in the male, basal joint short and stout, 2nd globose, 3rd and 4th not longer than the 1st, 5th and following long and clavate, the apical joint short and curved: 11-jointed and much shorter in the female.

Labrum very minute, hairy and dilated very much in front and somewhat cordiform (1).

Mandibles short, trigonate, slightly hooked and pointed at the apex (2).

Maxillæ small, terminated by 2 lobes regularly ciliated at the apex, external one the largest (3 *a*).

Palpi short subfiliform and 4-jointed, 3 first joints short, 4th thicker ovate, compressed and truncated at the apex (*b*).

Mentum broad, convex at the sides, emarginate before (4 *a*). *Labium* coriaceous cordate, forming two divaricating pubescent lobes (*b*). *Palpi* nearly as long as the maxillary and of the same form, triarticulate, attached to scapes at the base of the labium (*c*).

Head *suborbicular, sloped off in front:* eyes *lateral with a deep notch for the antennæ.* Thorax *orbicular quadrate with the anterior angles and margin a little reflected, and the base suddenly narrowed:* scutellum *elongate-triangular.* Elytra *quadrate or oblong, not half the length of the body, flat above, gaping behind, the apex of each being rounded.* Wings *very ample, folded on the back when at rest, and extending nearly to the apex of the* Abdomen *which is linear, concave above, convex beneath.* Legs, *anterior short, posterior long.* Thighs *very slender, terminated by an ovate club:* tibiæ *simple with small spurs at the apex:* tarsi 4*-jointed, basal joint considerably the longest, except in the anterior pair,* 3*rd bilobed,* 4*th clavate:* claws *curved and acute* (5, *a fore leg*).

MINOR *Linn.—Curt. Guide, Gen.* 412. 1.

In the Author's and other Cabinets.

MY lamented friend Latreille is the only naturalist of late who has done Linnæus the justice to retain the appellation he gave to the present group. In the first edition of this Work, I observed that the genus Necydalis of Latreille ought probably to form two genera: I had therefore adopted Fabricius's generic name for the species with short elytra, and those with longer and subulated elytra (*N. rufa* Linn. &c., forming Latreille's second division,) might retain the appellation of Necydalis; but since finding that this

FIG. 4.—Facsimile of page from second edition.

4.

PELTASTES PINI.

ORDER Hymenoptera. FAM. Ichneumonidæ *Lat.*
Type of the Genus Ichneumon necatorius *Fab.*

PELTASTES *Ill.* Ichneumon *Fab., Lat.* Metopius *Pz.*
Antennæ filiform, composed of 60 joints and upwards, inserted near the crown of the head, and equidistant from the eyes and each other. (1.)*
Clypeus formed like an escutcheon, pointed in the centre. (1.)
Labrum triangular, rounded in front. (2.)
Mandibles slightly arcuated, strong, acute, bifid near their extremities. (3. 3.)
Maxillæ short, corneous, rounded, ciliated, irregular at their outer edge. (4. a.): *Maxillary palpi* very long, hairy, 5-jointed, first joint straight cylindric; second very large, thick, clavate; third thicker than the first and nearly as long, fourth very small, fifth length of the first, cylindric. (4. b.)
Mentum oblong (5.a): *palpi* short, hairy, 4-jointed, nearly equal, inserted near the apex of the mentum (5. b.) *Lip* membranaceous, striated, sides conniving externally. (5. c.)

Superior wings *with the first submarginal cell very large, the* 2 *discoidal cells situated longitudinally one above the other.*
Abdomen *cylindric, almost sessile, composed of* 7 *joints in the male and* 6 *joints in the female*: (7) *Under side of abdomen of male.*
Oviduct *concealed*: (6) *Underside of abdomen of female.*
Tarsi *with* 5 *joints*: (8) *Part of hinder leg.*

P. PINI *nob.*
Black, deeply and closely punctured; clypeus yellow; thorax with 8 yellow spots before the insertion of the wings: 2 at the base of the scutellum, which is square, bidentate, and margined with yellow behind; first and second segments of abdomen with two yellow spots, the remainder margined with yellow; wings obscure with ferruginous nervures. Antennæ black above, ferruginous beneath; legs yellow; first pair palest: hinder thighs striped black inside.

In the Cabinet of Mr. Bentley.

THE insects of this genus, like those of the whole family, are parasitic, depositing their eggs in the larvæ of Lepidoptera, which as soon as they hatch begin to feed upon the muscles

* The dissections of the mouth are taken from the type of the genus, but the other figures are drawn from the species figured in the plate.

FIG. 5.—Facsimile of page from first edition.

4.

PELTASTES DENTATUS.

ORDER Hymenoptera. FAM. Ichneumonidæ *Lat., Leach.*

Type of the Genus Ichneumon necatorius *Fab.*

PELTASTES *Ill.*—Metopius *Panz., Lat.*—Ichneumon *Forst., Fab., Marsh., Panz., Jur.*

Antennæ inserted above the middle of the face, in 2 cavities between the eyes, long, robust, straight, setaceous and attenuated towards the base, composed of 60 joints and upwards (fig. 1* a).

Labrum triangular rounded and ciliated in front (2).

Mandibles strong, slightly arcuated, acute, bifid near the apex (3, 3).

Maxillæ terminated by 2 lobes nearly of equal size, the internal one almost naked, the external very pilose and dilated (4 a). *Palpi* very long and hairy, 5-jointed, basal and 3rd joints nearly of equal size, 2nd very large, subobovate, 4th the smallest, 5th long and slender (4 b).

Mentum oblong (5 a). *Palpi* short, hairy, composed of 4 nearly equal joints (b). *Lip* large, membranous, striated, sides recurved (c).

Head *rather small, transverse; face scutiform sometimes acuminated between the antennæ* (1*). Eyes *oblong*. Ocelli 3 *in a depressed triangle.* Thorax *short globose*. Scutellum *quadrate, the sides reflexed and produced at the angles.* Abdomen *almost sessile, the basal joint being scarcely narrowed at its attachment, long, somewhat ovate and depressed, concave beneath; composed of* 8 *joints in the male* (7 *the underside of apex*)*; and* 7 *in the female* (6 *the underside*). Ovipositor *nearly concealed.* Wings *shorter than the body; superior with one long marginal and* 3 *submarginal cells, the middle one small rhomboidal.* Legs; 4 *first short and small, posterior longer and robust.* Tibiæ *spurred, the posterior pair with* 2 *spines at the apex.* Tarsi 5-*jointed.* Claws *strong.* Pulvilli *large* (8†, *tarsus, &c. of a hind leg*).

Larvæ *parasitic feeding upon the caterpillars of various Bombycidæ.*

Obs. *the Trophi and fig.* 6 *are drawn from the type, and the other parts are taken from* P. dentatus.

DENTATUS *Fab. Ent. Syst.* 2. 180. 192.—Micratorius, *Fab. Syst., Piez.* 62. 41.—Pini *Curtis Brit. Ent. ed.* 1. *fol.* 4.

Black, deeply and thickly punctured: antennæ ochraceous beneath: nasus yellow. Thorax with 8 yellow spots before the insertion of the wings, and 2 at the base of the scutellum, which is margined with yellow behind. Abdomen with 4 yellow spots on the 1st and 2nd segments, the remainder margined with yellow. Wings obscure ferruginous, stigma and nervures brighter. Legs yellow, 1st pair the palest: the posterior thighs striped black inside.

In the Author's and other Cabinets.

PELTASTES receives its generic name from the face forming an escutcheon or shield: like the rest of the family these insects are parasitic in the larva state, the females depositing their eggs in the

FIG. 6.—Facsimile of page from second edition.

25.

PSEN EQUESTRIS.

ORDER Hymenoptera. FAM. Larradæ *Lat., Leach.*

Type of the Genus Trypoxylon atratum *Fab.*

PSEN *Lat., Jur., Panz.* Trypoxylon, Pelopæus *Fab.*

Antennæ inserted near the centre of the face, clavate, curved, smooth, 12-jointed in the female, 13-jointed in the male; first joint large, second small, terminal joint ovate. (1.)

Labrum exserted, transverse, subrotundate before, entire, ciliated. (2.)

Mandibles slender, scarcely arcuated, unidentate internally. (3.)

Maxillæ coriaceous, divided transversely, terminal process nearly membranaceous, rounded and ciliated: *Palpi* elongated, unequal, 6-jointed; first joint very small, third largest, sixth slender. (4.)

Mentum large, dilated in the centre, hairy (5. a.), (the point to which the maxilla is attached is shown at e.) : *Palpi* long, 4-jointed, first joint long, second and third short, last robust, ovate. (b.)

Lip short, with the edges conniving internally. (c.)

Clypeus *subrotundate, anterior margin elevated.* Head *transverse, as broad as thorax, with a tubercle between the antennæ.* Eyes *oval, entire, remote.* Ocelli 3, *inserted on crown of head in a triangle.* Thorax *short, nearly ovate.* Scutellum *narrow, small.* Abdomen *ovate-conic, with an elongated, abrupt peduncle.* Superior wings *with one marginal cell, not extending to the apex, and three perfect submarginal cells, the middle one nearly trigonate, either receiving one or two recurrent nerves.* Inferior wings *with two complete basal cells.* Legs *rather small.* Tibiæ *spined.* Tarsi 5*-jointed, first joint nearly as long as the three following, last terminated by simple claws and pulvilli.* (8. *a fore leg.*)

EQUESTRIS *Fab. Syst. Piezatorum, p.* 182. *n.* 6.

Black: clypeus and face silvery with hair, shining; first segment of abdomen rufous, with a black spot at its base; second entirely, and third partly, rufous. Wings hyaline, iridescent. Antennæ rufous beneath. Thighs and coxæ black. Tibiæ and tarsi pale ferruginous, the former annulated with black.

In the Cabinets of Mr. Haworth and the Author.

THIS pretty little species I took flying near Lyndhurst in the New Forest the end of August 1822. Mr. Haworth has also taken it in the neighbourhood of London. My specimens per-

FIG. 7.—Facsimile of page from first edition.

25.

PSEN EQUESTRIS.

ORDER Hymenoptera. FAM. Larridæ *Lat.*

Type of the Genus, Pelopæus compressicornis *Fab.*

PSEN *Lat., Jur., Panz., Van. Lind., Shuck., Curt.*—Trypoxylon, Pelopæus *Fab.*—Mimesa *Shuck.*

Antennæ inserted near the centre of the face, clavate, curved, and 12-jointed in the female (1): 13-jointed and more filiform in the male; basal joint large, second small, terminal joint ovate. (1 ♂.)

Labrum transverse, subrotundate before, entire and ciliated. (2.)

Mandibles slender, scarcely arcuated, bidentate, the teeth obtuse. (3.)

Maxillæ divided transversely, terminal lobe rounded and ciliated: *Palpi* longish, 6-jointed; first joint very small, third the largest, fourth as long, fifth the longest, sixth long and slender. (4.)

Mentum large, dilated in the centre, hairy (5. *a.* the point to which the maxilla is attached is shown at *e.*): *Palpi* long, 4-jointed, first joint very long, second and third short, fourth robust, elongate-ovate. (*b.*) *Lip* short and broad, the edges conniving internally. (*c.*)

Clypeus *convex and rounded, anterior margin elevated.* Head *transverse, as broad as the thorax, with a tubercle between the antennæ.* Eyes *oval, entire, remote.* Ocelli 3, *inserted on the crown in a triangle.* Thorax *short, nearly ovate.* Scutellum *small and subquadrate.* Abdomen *ovate-conic, with an elongated linear petiole.* Superior wings *with a lanceolate marginal cell, not extending to the apex, and three perfect submarginal cells, the middle one trigonate, receiving either one or two recurrent nervures.* Legs *rather small.* Tibiæ *spurred.* Tarsi *5-jointed, basal joint nearly as long as the three following, last terminated by simple claws and pulvilli.* (8. *a fore leg.*)

EQUESTRIS *Fab.—Curt. Guide, Gen.* 691. 3.

Black: clypeus and face silvery with hair, shining; first segment of abdomen rufous, with a black spot at its base; second entirely, and third partly, rufous in the female, with the 2nd segment only rufous in the male: wings hyaline, iridescent: antennæ rufous beneath: thighs and coxæ black: tibiæ and tarsi pale ferruginous, the hinder tibiæ subochreous at the base.

In the Author's and other Cabinets.

THE three lobes of the lip mentioned by Latreille in his observations upon the *Larridæ*, I could not discover in the species dissected; and he does not mention that organ in his generic description. The females from which the characters and figures are taken, are armed with sharp stings, that are not entirely concealed.

In my illustration of the genus *Pemphredon*, fol. 632, I have al-

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FIG. 8.—Facsimile of page from second edition.

7.

ODENESIS PINI. Pine Lappet.

ORDER Lepidoptera. FAM. Bombycidæ *Lat.*
Type of the Genus Bombyx potatoria *L.*

ODENESIS *Germar.* Gastropacha *Ochs., Germ., Leach.* Bombyx *Lin., Fab., Lat., Haw.*

Antennæ nearly straight, setaceous, strongly bipectinated in the male (1. a.); slightly bipectinated in the female (2.)

Maxillæ none? *Mandibles* none?

Palpi 2, not very long, porrected, 3-jointed, hairy like a brush in the female (3.): more compact and acute in the male. Middle joint twice the length of either of the others (4): with hair removed to show the joints.

Thorax *not crested.* Abdomen *of male divided at the apex, and bent upwards when viewed sideways.* Wings *entire, superior ones when at rest deflexed, and the inferior projecting beyond them.*

Larva *with* 16 *feet: its hinder ones formed for walking, flat and smooth beneath, rounded above, somewhat hairy with a slight tuberculated whart upon the penultimate joint, and fasciculi of hairs disposed along the sides.* Ochs.

Pupa *with its segments simple, inclosed in an oblong soft cocoon.*

O. PINI *Linn. Faun. Suec.* 1104. *Haw. Lep. Brit. p.* 80. 4. *Roes. Ins. vol.* i. *p.* 59.

Head, thorax and abdomen (of the male) pale fuscous. Upper wings cinereous, chesnut-brown at the base extending one fourth of the wing, surrounding a white lunular spot: an ochraceous fascia strongly marked in its outline running across parallel with the ciliated margin, very much sinuated behind, crenated before. Under wings pale chesnut. Female one-third larger than the male, similar in its markings, but throughout much paler.

In the Cabinet of the British Museum.

THE Lepidoptera is by far the most difficult of all the Orders to divide into genera, in consequence of the parts of the mouth being exceedingly minute and closely covered with scales or

FIG. 9.—Facsimile of page from first edition.

7.

DENDROLIMUS PINI.

The Pine Lappet Moth.

ORDER Lepidoptera. FAM. Bombycidæ.

Type of the Genus, Bombyx Pini *Linn.*

DENDROLIMUS *Germ.*—Eutricha *Hüb.*—Odenesis and Odonestis *Curt.*—Gastropacha *Och.*—Lasiocampa *Schr.*—Bombyx *Linn., Haw.,* &c.

Antennæ inserted towards the hind part of the head, close above the eyes, rather short and setaceous, composed of numerous joints, beautifully bipectinated in the male, each branch ciliated (1), the rays very short in the female (2).

Maxillæ short, slender and spiral.

Labial Palpi forming a short acute beak in the male, obtuse in the female, much more densely clothed with scales in the male than female, basal joint nearly as long as the 2nd which is subovate, 3rd as long as the first and cylindric.

Male *nearly as large as the female.* Head *clothed with a dense bunch of scales projecting over the forehead and meeting the palpi* (7). Eyes *rather small and orbicular, nearly of the same size in the sexes.* Thorax *suborbicular and not crested.* Abdomen *somewhat linear obtuse and tufted at the apex, which is slightly curved upward in the male, more robust and conical in the female.* Wings *deflexed when at rest, the inferior said to project beyond the anterior margin of the superior which are entire; somewhat obtuse in the male, more lanceolated in the female.* Cilia *thick and slightly indented.* Legs *densely clothed with scales, anterior shorter in the male than female.* Tibiæ; *anterior very short and densely clothed with longish hair in the male, with a broad and long internal horny lobe inserted near the base, small in the female; the other tibiæ densely clothed also and spurred.* Tarsi *shorter in the male than female, 5-jointed, basal joint of the anterior pair densely fringed with scales in the male.* Claws *strong curved and hooked.* Pulvilli *distinct.*

Larvæ *with* 6 *pectoral,* 8 *abdominal and* 2 *anal feet: flat and smooth beneath, rounded above, somewhat hairy, with a slight tuberculated wart upon the penultimate joint, and bundles of hairs disposed along the sides.* —Och.

Pupa *with its segments simple, inclosed in an oblong soft cocoon.*

PINI *Linn. Faun. Suec.* 292. 1104.—*Hüb. tab.* 42. *f.* 184 & 185.—*Röesel, v.* 1. *tab.* 59.—*Curtis's Guide, Gen.* 810[a].

Male reddish ochre, more or less gray: superior wings chestnut at the base and extending to the disc; before the middle is a sinuated striga with a lunular white spot upon it, and beyond the middle an oblique ochraceous fascia, the inner margin crenated with a brown line, the outer one very much sinuated and marked with strong brown spots: inferior wings pale castaneous. *Female* paler.

In the Cabinets of the British Museum, Mr. Vigors, and the Author.

1

FIG. 10.—Facsimile of page from second edition.

ODONESTIS POTATORIA.

The Drinker Moth.

ORDER Lepidoptera. FAM. Bombycidæ.

Type of the Genus, Bombyx Potatoria *Linn.*

ODONESTIS *Germ.*, *Curt.*—Odenesis *Lea.*, *Sam.*, *Curt.*—Eutricha *Hüb.*—Gastropacha *Och.*—Lasiocampa *Schr.*—Bombyx *Linn.*, *Haw.*, &c.

Antennæ inserted towards the hind part of the head, close above the eyes, long setaceous, composed of numerous joints, beautifully bipectinated in the male, the branches long, ciliated compressed and clavate at the apex, each furnished with a strong bristle: the rays short but distinct in the female.

Maxillæ none.

Labial Palpi forming a porrected beak, contiguous at the base, compressed towards the apex and closely applied, acute and densely clothed with compact scales in the male (pl. 7, f. 4 ♂), more obtuse, loose and hairy in the female (4 ♀), triarticulate, basal joint short and curved, 2nd long and stout, 3rd considerably longer than the 1st, subelliptical (4 a).

Male *smaller than the female.* Head *clothed with a dense bunch of scales projecting over the forehead and meeting the palpi.* Eyes *rather small and orbicular, larger in the male than female.* Thorax *suborbicular not crested.* Abdomen *linear obtuse, tufted at the apex and slightly cleft in the male; robust and ovate-conic in the female.* Wings *deflexed when at rest, the inferior projecting beyond the anterior margin of the superior ones, which are entire, obtuse in the male, sublanceolate in the female.* Cilia *thick and slightly crenated.* Legs *very hairy, anterior shorter in the male.* Tibiæ, *anterior very short and densely clothed with long hairs in the male, with a long and broad internal horny lobe inserted near the base, which is small in the female; the other tibiæ spurred.* Tarsi *shorter in the male than female, 5-jointed, the basal joint of the anterior pair in the male densely fringed with scales.* Claws *strong curved and hooked.* Pulvilli *distinct.*

Larvæ *with 6 pectoral, 8 abdominal, and 2 anal feet, somewhat hairy, with 2 rows of fasciculi down the back, a larger one behind the head and another near the apex.*

Pupa *inclosed in an oblong cocoon of close texture.*

POTATORIA *Linn. S. N.* 2. 813. 23.—*Don. Brit. Ins.* 5. *pl.* 148.—*Curt. Guide, Gen.* 810. 1.

Male ochraceous variegated with tawny, superior wings rather obtuse, with a curved brown striga at the base, and an oblique one stretching from the middle of the interior margin to the apex, between this and the posterior margin is a crenated curved line of the same colour, a whitish spot near the disc and a smaller one above it: inferior wings tawny. *Females* seldom so dark as the males.

3

FIG. 11.—Facsimile of page from second edition.

9.

ANTHRAX ORNATA.

ORDER Diptera. FAM. Anthracidæ *Lat.*
Type of the Genus Anthrax flava *Hgg.*

ANTHRAX *Scop., Fab., Lat.* Musca *Linn.*

Antennæ porrected, remote, 3-jointed, the first article cylindric, clavate, twice the length of the second; with long and thick tufts of hair; second nearly globular and hairy; third nearly naked, somewhat pear-shaped, with a long style terminated by a tuft of hair, or ovate with a 1- or 2-jointed style. (3.)

Head subglobose, with 3 stemmata placed upon a little tubercle: eyes reniform, converging behind, green when alive. (2.)

Trophi either entirely concealed, or projecting a little beyond the head. (1. a. part of the head which receives the trophi, and which came away with them upon dissection.)

Labrum (1. b.) horny, acute, convex above, concave beneath, inclosing the tongue.

Tongue considerably longer than the labrum, corneous, acuminate. (1. c.)

Mandibles none.

Maxillæ (1. e.) horny, linear, acute, nearly as long as the labrum.

Palpi 2, received into the cavity of the mouth, simple, cylindric, hairy, attached to the side of the maxillæ near the base, half their length. (1. f.)

Mentum? cylindrical, hollow above to receive the tongue and labrum. (1. h.)

Lip fleshy, oblong, bipartite, ribbed, extending as far as the tongue. (1. g.)

Head *level with the thorax.* Body *7-jointed, short, nearly quadrate, abruptly acuminated behind.* Wings *divaricating, long, lanceolate.* (9.) Halteres *often concealed in the hair of the body.* Posterior legs *the longest.* Tarsi 5, *sometimes terminated by 3 claws: pulvilli obsolete.* (8.)

A. ORNATA *Hoffmansegg.*

Black shining: Head covered with black hair between the eyes, silvery behind, clypeus and under side of head with golden hair. Thorax covered with ochraceous hair before, nearly naked in the centre. Scutellum brownish. Abdomen covered with short golden hair, the sides surrounded with alternate fasciculi of fine white and black hair, 3rd and 4th segments with white fasciæ interrupted in the middle, sixth with a white spot in the centre, last joint very white with hair. Wings transparent, many-nerved, with a brunneous cloud extending two thirds the length, sinuated at the posterior margin, with a transverse transparent spot near the base, a larger one in the centre, and 2 others near the margin at the union of the nerves. Legs black, femurs and tibiæ covered with close yellow hairs. Halteres yellow.

In the Cabinets of Mr. Dale, Mr. Bentley, and the Author.

FIG. 12.—Facsimile of page from first edition.

9.

ANTHRAX ORNATA.

ORDER Diptera. FAM. Anthracidæ.

Type of the Genus, Anthrax hottentotta *Linn.*

ANTHRAX *Scop., Fab., Lat., Meig., Curt.*—Musca *Linn., Geof.*
Antennæ porrected, remote, 4-jointed, basal joint twice as long as the 2nd, cylindric subclavate, producing long and thick bundles of hair, 2nd nearly globose, hairy, 3rd with a few hairs only, very long, the base stout, subconic, the apex forming a long beak, 4th joint minute ovate (3); sometimes there is a 5th joint like a short bristle, at others the 3rd joint is terminated by a coronet of short bristles.
Trophi either entirely concealed, or projecting a little beyond the head.
Labrum horny, acute, concavo-convex, inclosing the tongue (1 b).
Tongue considerably longer than the labrum, corneous, acuminated (c).
Mandibles none.
Maxillæ horny, linear, acute, nearly as long as the labrum (e). *Palpi* received into the cavity of the mouth, attached to the sides of the maxillæ near the base, half their length, slender, cylindric and pilose (f).
Mentum cylindric, hollow above (h), receiving the tongue and labrum.
Lip fleshy, oblong, bilobed at the apex, ribbed, extending as far as the tongue (g).

Head *globose.* Eyes *alike in both sexes, reniform, covering nearly the whole head, approximating behind* (2). Ocelli *elevated, placed in a compact triangle at the back of the head.* Thorax *large orbicular-quadrate.* Scutellum *broad and subtrigonate.* Abdomen *oblong, truncated, composed of 7 joints, terminal one small and triangular.* Wings *expanded when at rest, long and lanceolate, with numerous nervures, the costa dilated at the base and generally bristly.* Halteres *small and capitate, often concealed.* Legs *slender, simple, posterior the longest.* Tarsi *attenuated to the apex, 5-jointed, basal joint the longest, terminated by 2 bent claws.* Pulvilli *minute* (8 † *hind leg*).

ORNATA *Hoff.?—Curtis's Guide, Gen.* 1193. 4.

In the Cabinets of Mr. Dale, the Author, &c.

MEIGEN having very judiciously separated *A. Belzebul* from Anthrax, and given it the generic name of *Stygia* (since superseded by *Lomatia*), the family now contains four genera, two of which are British. It is probable that the sombre aspect of some of the exotic species may have induced authors to apply the name of Anthrax to this genus; and the association being carried further, has led to the

1

FIG. 13.—Facsimile of page from second edition.

14.

HÆMOBORA PALLIPES.

ORDER Omaloptera *Leach.* FAM. Hippoboscidæ *Leach.*
Type of the Genus H. pallipes *nob.*

HÆMOBORA *nob.*

Antennæ inserted close to the anterior angles of the clypeus, globular, hairy, and sunk into the head. (2. a.)

Labrum horny, elongate, hollow, slightly arcuated, inclosing the tongue.

Tongue nearly as long as labrum, slender.

Lip horny, arched, hollow, inclosing the labrum and tongue. (1. g.)

Maxillæ? rigid, obtuse, ciliated with strong hairs, united at their internal edges, bent downwards, inclosing the proboscis, and extending beyond the head like a beak. (1. and 2. e.)

Mentum large, coriaceous, membranaceous, covering and concealing the base of proboscis. (1. h.)

Ocelli 3, in a triangle, sunk in foveolæ.

Wings very long, rounded, first marginal or mediastinal cell extending one-third the length of the wing; second marginal cell very long, rounded at the end, discoidal cells united, 6 obscure, imperfect nerves extending to posterior margin.

Tarsi 5-jointed, last the longest; *Claws*, lengthened at their base on each side the pulvillus. (8.)

Head *broader than long, somewhat triangular, divided from the thorax.* Eyes *very remote, small.* Thorax *a little broader than head, nearly quadrate, dilated near the base of wings, notched anteriorly.* Scutellum *broad and short.* Halteres *very distinct.* Abdomen *small, nearly conical, peduncled, coriaceous towards its base, the remainder spongy.* Feet *extended, thick, first pair remote from the wings, inserted almost under the head.*

Larva *nourished in the abdomen of the mother, and excluded before transformation.* Lat.

Pupa *inclosed in the indurated skin of the larva, sub-orbicularly impressed at one end.* Lat.

H. pallipes *nob.*

Shining, with strong hairs scattered over the limbs and body; pale and dull; greenish-yellow clouded with brown. Eyes and claws black. Thorax beneath punctured and covered with short, strong erect hairs. Wings nearly transparent, nerves yellow, the costa slightly ciliated.

In the Cabinet of Mr. Samouelle.

THE curious tribe to which this Insect belongs forms a 2nd division of Latreille's Diptera, and is called *Eproboscidea.*

FIG. 14.—Facsimile of page from first edition.

14.

HÆMOBORA PALLIPES.

ORDER Omaloptera. FAM. Hippoboscidæ.

Type of the Genus, H. pallipes *Curt.*

HÆMOBORA *Curt.*

Antennæ inserted close to the anterior angles of the clypeus, globular, hairy, and sunk into the head (2 *a*).

Labrum horny, elongated, hollow, slightly arcuated, inclosing the tongue.

Tongue nearly as long as the labrum, slender.

Lip horny, arched, hollow, inclosing the labrum and tongue (1 *g*).

Maxillæ? rigid, obtuse, ciliated with strong hairs, united at their internal edges, bent downwards, inclosing the proboscis, and extending beyond the head like a beak (1 and 2 *e*).

Mentum large, coriaceous, membranaceous, covering and concealing the base of the proboscis (1 *h*).

Head *broader than long, somewhat transverse-ovate, closely adhering to the thorax:* eyes *large very remote:* ocelli 3 *in triangle.* Thorax *a little broader than the head, nearly quadrate, dilated near the base of the wings, notched anteriorly:* scutellum *broad and short.* Wings *very long and rounded, first marginal or mediastinal cell extending one-third the length of the wing; 2nd marginal cell very long, rounded at the end, discoidal cells united, 6 obscure and imperfect nervures extending to the posterior margin:* Halteres *very distinct and capitate.* Abdomen *small, nearly conical, peduncled spongy, coriaceous towards its base.* Legs *thick, first pair remote from the others, and inserted almost under the head:* tarsi 5*-jointed, terminal joint the longest:* claws *lengthened at their base on each side the pulvillus* (8).

PALLIPES *Curt. Guide, Gen.* 1355. 1.

Shining, pale and dull greenish-yellow, clouded with brown, with strong hairs scattered over the body and legs: eyes and claws black: thorax beneath punctured and covered with short strong erect hairs: wings nearly transparent, nervures yellow, the costa slightly ciliated.

In the Cabinet of Mr. Samouelle.

The curious tribe to which this insect belongs forms a 2nd division of Latreille's Diptera, and is called Eproboscidea. Dr. Leach, who investigated the species with great attention, and published his observations in the second volume of the "Wernerian Transactions," subsequently constituted them into an Order, the propriety of which cannot be doubted when we consider that these insects are very different to the Diptera both in structure and œconomy.

The genus that I have proposed appears to connect Hippobosca (Pl. 421) and Ornithomyia. It will be seen that my ideas regarding the mouth differ from those of other authors; but as an universal

FIG. 15.—Facsimile of page from second edition.

PART II. REPRINTS AND REVISIONS

In 1911 Sherborn and Durrant stated that the publication of the parts proceeded "with great regularity, commencing January 1824, and finishing December 1839, so the dates of the plates may be accepted with certainty." The implication here and elsewhere that after plate 10 (parts 1 and 2) four plates were issued each month and dated accordingly, is susceptible to checking only in part by any means at my disposal. However, it did seem worth while to examine all the plates in the first edition to see if the dates on the plates bore out this assumption. This examination revealed no case where the dates do not agree with the monthly schedule.

This examination of dates was made in the copy in the United States Department of Agriculture library, which is in numerical order. In the course of this examination it was discovered that commencing with plate 386 many of the plates had no date line at the bottom. These plates were on somewhat different paper from the others and had a different appearance. In all, 89 of these undated plates occurred.

No explanation being obvious, additional sets were obtained for comparison. The only other set examined which is arranged in numerical order [3] also contains many of these undated plates, but they number 103, with only 36 of these on plates corresponding to those in the first set. The remainder of the undated plates are of lower number, starting with 83. It was further noted in this second set that many other plates were obviously redrawn and of poorer workmanship.

These discoveries led to the examination of two more sets, these both in systematic order.[4] In neither of these were any of the undated plates found, but numerous other inconsistencies added to the puzzle. A tabulation of the five sets in parallel columns in numerical order failed to throw much light on the problem, but certain facts have been made clear.

1. Unquestionable original examples of all 770 plates have been seen, engraved in high quality by Curtis himself (at least at first) and showing no deviation in style.

2. Curtis' reprints of plates 1-50 are equally recognizable, the plate number always being underscored (the text was reset and number underscored on 1-34 only).

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[3] Through the courtesy of the Rutgers University Library, New Brunswick, N. J.

[4] Through the courtesy of the library of the American Museum of Natural History, New York City, and of the Peabody Institute Library, Baltimore, Md.

3. The reprints had an additional number at the bottom to indicate the position of the plate in the systematic arrangement. But 10 plates are known without this number.

4. Although it was not feasible to compare all the 770 plates of all five sets, it was noticed that some plates in some sets had been redrawn. Redrawn copies (of a poorer workmanship) are known of five plates, each in only one set.

5. In addition to engravings and reengravings, many plates exist in a poorer type of reproduction that is obviously lithography. These plates do not have the impression lines of the copper engraving plates and are much coarser. These are known for 267 plates but are of several minor types. Straight copies of engravings by lithograph occur for 119 plates. These have the date lines, but seven of them exist also with the additional number at the bottom (apparently also redrawn in each case).

6. Many lithographs occur without the date line at the bottom (155 plates), in some obviously deleted because remnants are still visible.

7. A lithograph of one of the second-edition plates has been seen. It has both the date and the extra number. This plate (No. 34) is known also as an original engraving of the second edition and as both engraving and lithograph of the first edition.

It appears obvious from the above that in addition to the two known editions, there are plate alterations, later engravings, lithographs, stone alterations, and later lithographs. No definite clue has been uncovered as to the age of any of these (except the two definite editions) or the order in which they appeared. The lithographs might be assumed to be later than 1840 and produced by someone other than Curtis, but they occur in four of the five sets before me, including both of the ones in numerical order, one of them in all other respects a complete first edition.

The condition of the five sets may be summarized as follows:

U.S.N.M. All original first-edition engravings except for second-edition plates 1-50 (plate 17 first edition, text second).

U.S.D.A. All original first-edition engravings up to No. 385, with many of the others being lithographs.

A.M.N.H. Second-edition engravings complete; first edition with occasional lithographs.

Rutgers. Engravings of both editions intermixed with occasional lithographs.

Peabody. Engravings of both editions intermixed with occasional lithographs; with one lithograph of a second-edition plate, and several other peculiarities.

Although it is impossible to publish the entire tabulation of these plates, the actual state of certain plates in each set is shown in the following table. Symbols are used to save space.

1—First edition (plates 1-769 and 205*).
2—Second edition (plates 1-50).
E—Engraved.
L—Lithographed.
n—With serial number added at bottom.
r—Redrawn (on a new copper plate).
u—Undated.

Plate	U.S.D.A.	Rutgers	U.S.N.M.	Peabody	A.M.N.H.
1	1E	2E	2E	2E	2E
5	1E	1Ln	2E	1Ln	2E
7	1E	2E	2Eu	2E	2E
11	1E	1Ln	2Eu	2E	2E
15	1E	1L	2Eu	1L	2E
34	1E	1Ln	2E	2L	2E
69	1E	1E	1E	1Er	1E
117	1E	1Lu	1E	1E	1Er
169	1E	1E	1E	1E	1E
378	1E	1L	1E	1E	1E
386	1Lu	1Lu	1E	1L	1E
387	1Lu	1Lu	1E	1E	1E
403	1Lu	1E	1E	1E	1E
768	1E	1E	1En	1En	1E

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FACSIMILE OF PLATE FROM FIRST EDITION

Facsimile of Plate from Second Edition

Facsimile of Plate from First Edition

FACSIMILE OF PLATE FROM SECOND EDITION

SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 107, NUMBER 6

PREHISTORY AND THE MISSOURI VALLEY DEVELOPMENT PROGRAM: SUMMARY REPORT ON THE MISSOURI RIVER BASIN ARCHEOLOGICAL SURVEY IN 1946

(WITH TWO PLATES)

BY
WALDO R. WEDEL
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CITY OF WASHINGTON
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Archeological investigations in the Missouri River Basin have been carried on intermittently for a little more than half a century. There were, to be sure, terse comments by explorers, travelers, and others at least as far back as the time of Lewis and Clark, but these observations were usually incidental to other activities. With a few notable exceptions, most of the work prior to 1920 was done with little or no sense of problem and for the primary purpose of acquiring museum pieces. More recently, and particularly in the past two or three decades, systematic archeology has taken the place of the earlier relic-gathering, and with broadening of the field of inquiry, there has resulted a rather drastic overturning of former concepts concerning the pre-white occupation of the region. It is apparent already that the bison-hunting, war-bonneted horsemen of the period of America's westward expansion are a late phenomenon; that behind them, in areas climatically suitable, was a long period of residence by corn-growing, village-dwelling peoples; and that the total span of man's occupancy of the region is a very long one—a period to be measured possibly in terms of thousands of years. The outline of the story is emerging; the details remain to be filled in.

Postwar archeology in the Missouri River Basin, as it prepares to resume the researches interrupted during the early 1940's, finds itself face to face with the prospect of losing a very large part of its basic materials. Here, as elsewhere throughout the major river valleys of the United States, the flood control and reclamation program of the Federal Government will bring complete destruction to hundreds of archeological sites of varied nature and antiquity. Only prompt action, carefully planned, fully coordinated throughout the region involved, and executed on a scale commensurate with the basic program of basin development, will enable us to salvage the information needed to reconstruct the prehistory of the region.

The Missouri River Basin comprises a territory of nearly 530,000 square miles—approximately one-sixth the area of the continental United States. It extends about 1,350 miles from Glacier National Park, Mont., in the northwest to St. Louis, Mo., in the southeast, and more than 700 miles from Colorado's South Park in the southwest to Devils Lake, N. D., in the northeast. The Missouri River itself, from its source at Three Forks, Mont., flows 2,500 miles in a general easterly and southerly direction through or along seven States. With its innumerable tributaries, it drains all of the State of Nebraska, portions of the States of Montana, Wyoming, Colorado, North Dakota, South Dakota, Kansas, Minnesota, Iowa, and Missouri, and small areas in the Canadian provinces of Alberta and Saskatchewan.

There is no need here to dwell on the wide diversity of terrain, climate, native fauna and flora, and other environmental aspects of this vast region. Briefly, the Basin rises in altitude from about 400 feet above sea level at the mouth of the Missouri to the 10,000- to 14,000-foot snow-capped summits of the Continental Divide in Montana and Colorado. The watershed consists largely of plains, but in south-central Missouri, in western South Dakota, along the easterly slopes of the Rockies, and elsewhere there are rugged areas of considerable extent. Annual precipitation ranges from 40 inches at the mouth of the Missouri to less than 10 inches in parts of Wyoming and Montana. East and north of the Missouri River the soils are mainly of glacial origin; to the west and south residual, alluvial, and sandy aeolian soils predominate. Native vegetation consists of oak-hickory hardwood forests in the extreme southeast, successively replaced toward the west by tall-grass prairie, short-grass plains, the sagebrush and desert scrub of Wyoming, and finally the western pine forests of the Rocky Mountains. Like the region, its ethnography and its archeological remains also show marked and significant variation from one section to another.

In the historic period, that is, since approximately 1775, the Missouri River watershed has been inhabited by numerous Indian tribes of varied linguistic affiliations and diverse cultural practices. Some were demonstrably late arrivals; others had apparently been long resident in the area when first recorded by white visitors. In the semiarid grasslands of the western plains and along the base of the Rockies roamed several tribes who may be collectively termed the migratory bison hunters. In north-central Montana, north of Musselshell River and west of the mouth of Milk River, were the Blackfoot and Gros Ventres, with the Assiniboin to the east. On the Yellowstone River and its southerly branches in southeastern Montana and northeastern

Wyoming, were the Crow. Between Heart River in North Dakota and the upper Platte were the Teton Dakota. The Cheyenne, agriculturists in North Dakota as late as 1750, by 1800 were sharing with the Arapaho the region between the upper Platte and the Arkansas. In the sagebrush plains of central Wyoming were the Wind River Shoshone, whose relationships were strongest with tribes in the Great Basin to the west. Often considered the "typical" peoples of the plains, these groups for the most part dwelt in portable skin tipis, practiced no agriculture or pottery-making, made extensive use of the dog (later the horse) and travois, and depended for their sustenance primarily on the bison.

In the eastern part of the Basin, along the Missouri River and on its larger tributaries, dwelt a series of semisedentary, corn-growing, pottery-making tribes. Perhaps best known among these, by reason of the stream of explorers, traders, artists, and adventurers who visited their great stockaded settlements in the 1800's, were the Hidatsa and Mandan of North Dakota and the Arikara in South Dakota. Downriver, in eastern Nebraska, were the Ponca, Omaha, Oto, and Missouri, the last-named tribe a late migrant from central Missouri; and, in the lower Platte-Loup district, the Pawnee. In northeastern Kansas were the Kansa, and to the east in Missouri, were the kindred Osage. These were the village tribes to whom the early fur-traders resorted, bringing both goods and epidemic diseases; and against whom the mounted warlike nomads from the western plains carried on a more or less constant series of raids. Here again, as with the nomadic tribes, there is evidence that not all the groups have been equally long in their historic locale; and also, that their respective histories will trace back through widely divergent developmental backgrounds.

To supplement the ethnic background for the research program reported in this paper, it may be helpful to sketch briefly what we know today of prehistory in the region—of man's activities here before the tribes named above were first met by white men.

On present evidence, it appears that the earliest inhabitants of the Missouri River Basin were hunting and gathering peoples, who grew no domestic crops and made no pottery. Their origin and physical appearance beyond the assumption that they were Indians, can only be guessed at. From the nature of their known campsites (pl. 1, fig. 1), it may be surmised that they lived in small bands which roamed from place to place as seasonal conditions or the needs of the moment dictated. It may be supposed also that their hunting methods, skin-working techniques, and other practices paralleled closely those observed by the first Spanish explorers who visited the Plains hunting tribes in the sixteenth century. Their remains have been found principally in and immediately east of the High Plains in Colorado, western Kansas, Nebraska, Wyoming, and Montana, in a region characterized by low precipitation and sparse vegetation. Some of these peoples evidently hunted the mammoth, now extinct forms of bison, and other large game; and there is evidence that they lived in a somewhat cooler and moister climate. From the locality in northeastern New Mexico where their distinctive form of projectile point was first recognized in association with extinct fauna, the term Folsom culture has been affixed to these remains. It has been estimated on geological evidence that the people of the Folsom culture lived as long ago as 10,000 to 25,000 years.

Following the Folsom peoples in the western plains, there seems to have been a succession of poorly defined and little-known potteryless groups. Their remains consist chiefly of chipped and other stone implements, bone refuse, hearth sites, and other camp litter. The widely distributed Yuma blades, whose associated artifact complex is still unclear, seemingly belongs to this post-Folsom period (pl. 1, fig. 2). Their relation to the Folsom culture is still in dispute; neither is it possible to relate them satisfactorily—if indeed a direct connection exists—to any of the presumably later remains found in caves, bison falls, and other sites in the Colorado-Wyoming-Montana region and immediately to the east. Further intensive research, particularly at stratified sites such as Signal Butte and Ash Hollow Cave in western Nebraska, and Pictograph Cave near Billings, Mont., will probably help solve this vexing problem.

Still undetermined is the time when cultivation of corn and beans began in the Missouri River Basin. Without question, however, it was some centuries prior to the European conquest beginning in the sixteenth century—quite possibly as much as five or six centuries before. The introduction of horticulture encouraged a more settled mode of life, the establishment of semipermanent villages, and ultimately a marked diversification of cultures. Archeologists, working partly through stratigraphy and partly by other more devious means, now recognize a succession of these semisedentary cultures. Their remains, as is to be expected for climatic and other environmental reasons, occur in greatest abundance and variety along the eastern portion of the Missouri Basin, though they have been found many hundreds of miles to the west on suitable tributary streams.

Widespread throughout the Missouri Basin area, and apparently representing the earliest pottery-makers in the region, are the somewhat varied remains designated as Woodland. The very limited excavations to date leave the nature of this occupancy all but unknown, though it seems likely that the settlements were mostly small and rather short-lived, with subsistence based at least as much on hunting as on agriculture. To the same general period, apparently, may be attributed the Hopewellian village sites and burial mounds of northwestern Missouri and northeastern Kansas.

Later came the more sedentary prehistoric village-dwellers. In the Nebraska-Kansas region these include the Upper Republican and Nebraska Culture remains—well-defined horizons whose exact counterparts on the upper Missouri are still to be fully worked out. These groups, in addition to hunting and fishing, practiced a fairly intensive corn and bean horticulture; villages were not fortified; and in the ruins of their earth-covered pithouses are to be found storage pits, agricultural tools, pottery, and a wide variety of bone, stone, horn, and shell artifacts, but no objects of white man's manufacture. They are thought to have occupied the region during approximately the thirteenth, fourteenth, and fifteenth centuries; probably some of the later communities on the east were in direct contact with Middle Mississippi groups along the lower Missouri. It is the remains from this period that are found in such relative profusion on most of the arable stream valleys east of the 100th meridian, and less commonly 200 miles or more yet farther to the west. From the character and abundance of their village sites, we surmise that they were moderately populous groups, that they dwelt in comparative peacefulness over a long period of time, that they had partially solved the problem of living together harmoniously in settled communities, and that they had acquired a somewhat greater degree of control over their local environment than their hunting predecessors possessed. It appears likely, at the same time, that adverse climatic conditions, particularly droughts, may have seriously affected the welfare of some of these peoples—in fact, that to some extent the story of successive occupancies of the region may reflect the vagaries of the environment.

Whatever the cause or causes, by the time the first white explorers reached the Missouri River watershed and contacted its native peoples in the mid-sixteenth century, the numerous small, widely scattered earthlodge villages in the western plains had been abandoned. Instead, corn-growing Indians dwelt in large towns, some of them strongly fortified (pl. 2, fig. 1), much farther to the east. To this general period, dating from approximately 1500 to 1700, belong a series of large Wichita (?) sites in central Kansas, the protohistoric Pawnee towns in the lower Loup district of east-central Nebraska, many of the Arikara, Middle Period Mandan, and Hidatsa settlements of the upper Missouri, and, we may suppose, some of the sites of the Cheyenne and other formerly sedentary tribes east of the upper Missouri. Introduction of the horse, arrival in the Missouri drainage of easterly groups such as the Oneota with new cultural elements, and the formation through necessity or choice of large community populations (pl. 2, fig. 2) all gave impetus to a rather remarkable florescence of culture. In the southwestern portions of the watershed dwelt a number of vaguely described and little-known peoples, partly hunters and partly tillers of the soil, who were possibly Apache; their hold on the region seems to have been a feeble one, and their interests were apparently southwestern rather than with the village tribes of the eastern plains. During the late 1700's and early 1800's, increasing pressure from the whites on the east, the introduction of smallpox and other devastating diseases, and above all the swarming in from all sides of tribes who committed themselves solely to raiding and the chase, reduced the once culturally important village tribes to a relatively insignificant role.

As the very brief and incomplete foregoing résumé suggests, there is a fairly well outlined sequence of native cultures for a large part of the Missouri Basin. There are strong suggestions that the increasingly sedentary nature and larger communities of the later occupations went hand in hand with improved domestic food plants, better agricultural methods, and greater crop yields. In short, for the eastern half of the region the story appears to be one of progressively better adaptations on man's part to a rather variable and uncertain habitat. It should be emphasized that at the moment it is the village tribes of the arable eastern plains whose antecedents seem best known, but even here there are great gaps in our knowledge. It is not at all clear for example, what the relationship was between the various recognized prehistoric corn-growing peoples and such historic tribes as the Pawnee, Arikara, Mandan, and their contemporaries. A whole host of problems presents itself in the shifting emphasis from hunting to corn cultivation and back to hunting, as evidenced in the still sketchy archeological record; in the transformation from small, scattered, loosely organized villages of a few dozen inhabitants to great, fortified towns of several thousand souls; and in the economic, social, and political readjustments that certainly arose from the constantly changing native ways of living. In the semiarid western sections of the Basin, notably Montana and Wyoming, the data on prehistory are infinitely more scattered, fragmentary, and unorganized.

Turning now to the problem immediately at hand, present plans of the Bureau of Reclamation, Department of Interior, and the Corps of Engineers, War Department, propose the eventual construction of more than 100 dams and reservoirs within the Missouri River Basin. Many will include power and irrigation, as well as flood and silt control, facilities—in all, "hundreds of major engineering works, such as dams and power plants, and thousands of important structures." Most of the projects are designed for the tributary streams, but with five huge earth-fill dams and two-thirds of the total reservoir capacity proposed for the mainstem of the Missouri between Yankton, S. D., and the mouth of Yellowstone River in eastern Montana. Except along the mainstem, the aggregate area to be flooded is small in proportion to the total valley area; but with dams ranging up to 200 feet or more in height, it is evident that considerable stretches of some of the valleys selected will be inundated.

It has been estimated, probably conservatively, that at least 80 percent of the archeological remains in the United States occur along the banks of rivers and creeks. In the Missouri River Basin, it is already evident that the townsites, camp grounds, burial places, pictographs, and other aboriginal remains occur mostly in the stream valleys near potable water, wood for fuel and building purposes, tillable soil, and cover for hunting. Scores of large townsites, some numbering hundreds of house ruins and evidently with populations once counted in the thousands, lie along the mainstem of the Missouri in North and South Dakota. Many of these are situated on benches 30 to 75 feet above normal stream level and seem certain to disappear beneath the rising waters of the projected reservoirs. Such tributary projects as the Osceola in Missouri, Tuttle Creek and Kanopolis in Kansas, Harlan County, Davis Creek, Boelus, and Medicine Creek in Nebraska, to mention only a few of those in localities whose archeology is partially known, will submerge additional unstudied historic and prehistoric sites. Other units in Wyoming, Montana, and the western portions of Kansas, Nebraska, and the Dakotas will be in a region that is disclosing an increasing number of less conspicuous but equally important campsites belonging to early man—the Folsom and perhaps other paleo-Indian groups. Here, too, paleontological deposits of economic and scientific importance will be destroyed by flooding.

The ancient occupants of these diverse localities and periods have left us no written records of their history and activities. Their habitation and burial sites, with such objects of everyday and special use as have survived passage of the years, are the sole documents from which

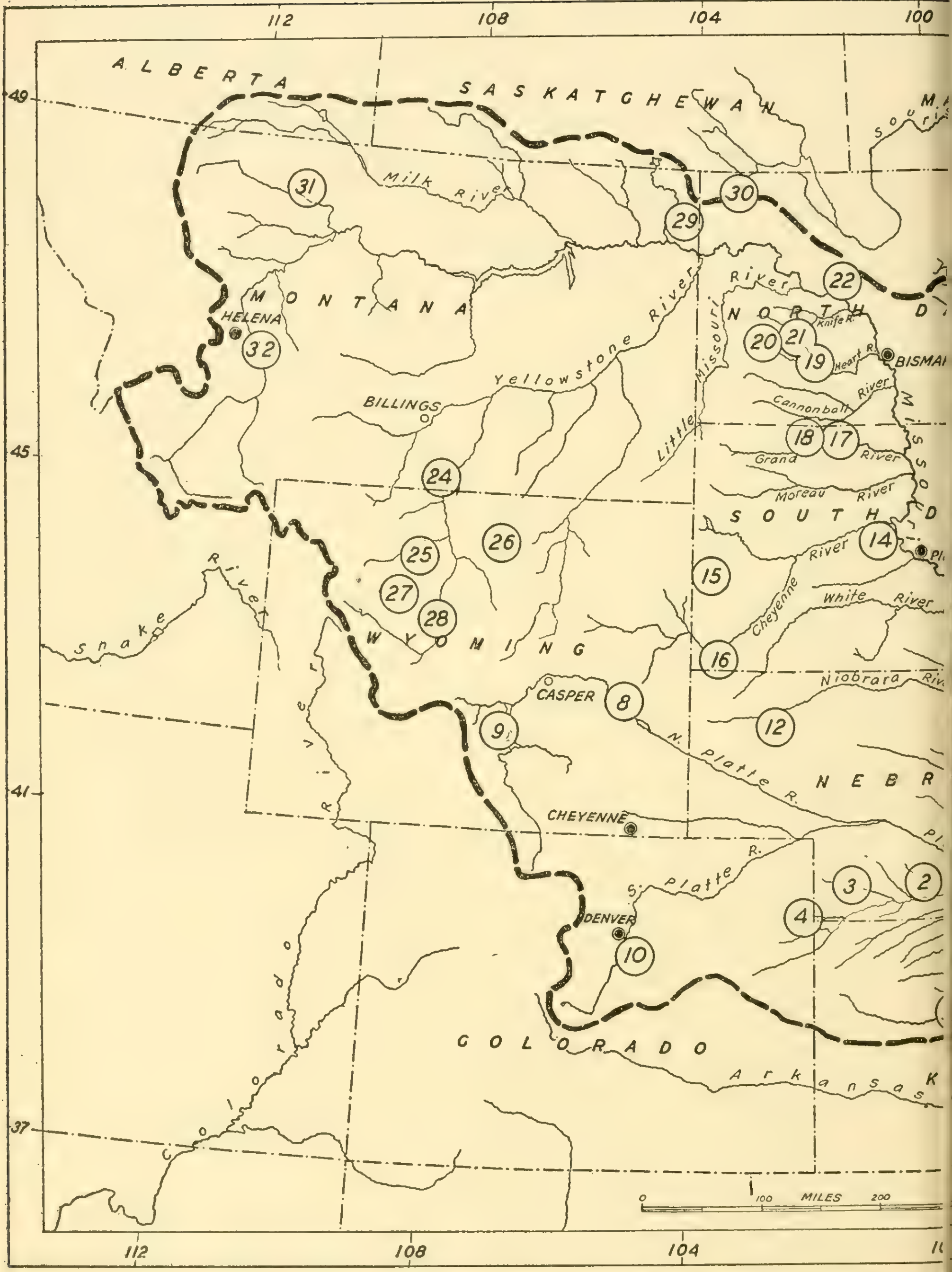
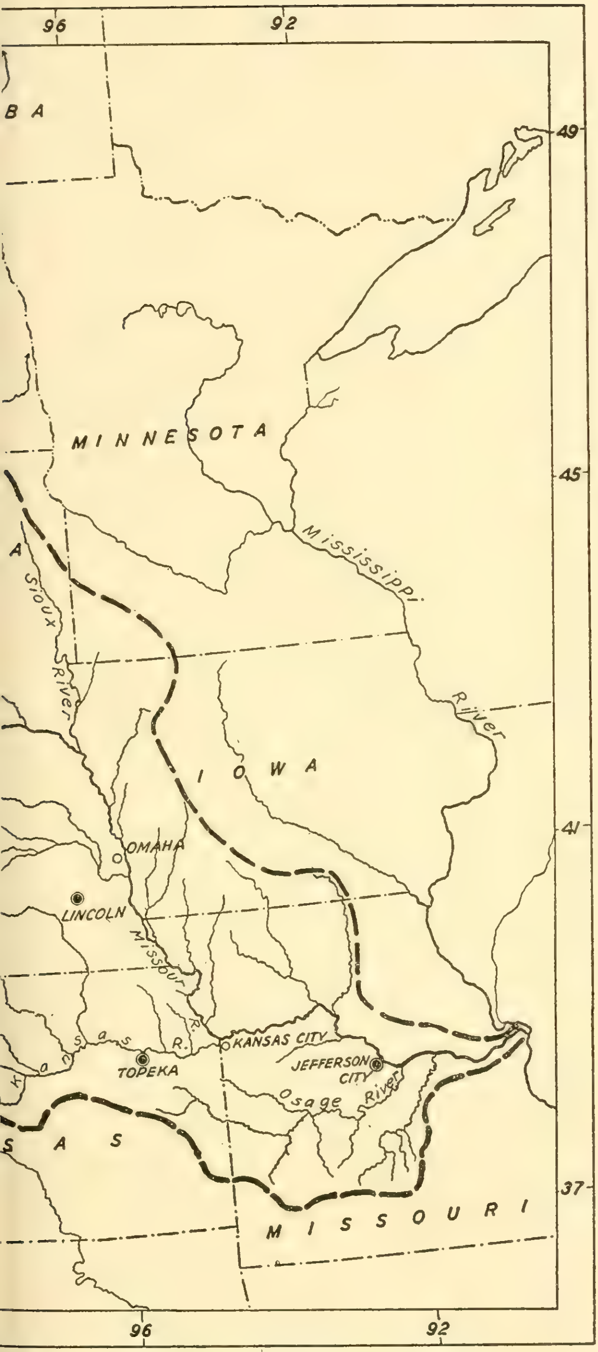


FIG. 1.—Map of Missouri River Basin (heavy broken line), showing reservoir projec
Missouri River Basin Survey in



1, Harlan County (C. of E.).
2, Medicine Creek.
3, Enders.
4, Wray.
5, Kirwin.
6, Kanopolis (C. of E.).
7, Cedar Bluff.
8, Glendo.
9, Kortes.
10, Cherry Creek (C. of E.).
11, Jamestown.
12, Box Butte.
13, Fort Randall damsite (C. of E.).
14, Oahe damsite (C. of E.).
15, Deerfield.
16, Angostura.
17, Blue Horse.
18, Shadehill.
19, Heart Butte.
20, Dickinson.
21, Broncho.
22, Garrison damsite (C. of E.).
23, Sheyenne.
24, Yellowtail.
25, Oregon Basin.
26, Lake Solitude.
27, Anchor.
28, Boysen.
29, Medicine Lake.
30, Crosby.
31, Tiber.
32, Canyon Ferry.
33, Devils Lake.
Des Lacs, N. D., omitted.

es visited by archeological field parties of the trained scientists may hope to reconstruct the story of man's centuries-long effort to dwell in the varied and often trying environment of the Missouri Basin.

At the request of the Bureau of Reclamation and the Corps of Engineers, the National Park Service, Department of the Interior, has undertaken a survey of recreation opportunities that may arise from construction of multipurpose reservoirs throughout the United States. Further, in recognition of the fact that numerous archeological and paleontological sites will be destroyed, the National Park Service and the Smithsonian Institution have entered into a memorandum of understanding. In accord with this agreement

> . . . the National Park Service, in the course of its recreational studies of the proposed reservoir areas will call to the attention of the Smithsonian Institution the locations of all of the proposed dams and reservoirs; and the Smithsonian Institution will advise the National Park Service as to the number and importance of the known archeological or paleontological sites located within such reservoir areas, and recommend such surveys in the field as seem indicated.

This memorandum of understanding, signed for the National Park Service on August 7, 1945, for the Smithsonian Institution on September 8, 1945, and approved by the Secretary of the Interior on October 9, 1945, is the basis for archeological and paleontological investigations wherever they are called for by the river development program. Like the river development plans, the scientific salvage program is of nation-wide scope. The Missouri River Basin project is the first of the full-scale River Basin Surveys, under the over-all direction of Dr. F. H. H. Roberts, Jr., to be undertaken by the Smithsonian Institution under this cooperative arrangement.

The program envisioned by the Smithsonian Institution for the Missouri River Basin has for its primary objective the fullest possible recording and salvaging of archeological and paleontological remains located within, and immediately adjacent to, the boundaries of authorized and proposed reservoir sites. Such a program must provide for (1) establishment of field office and laboratory facilities where specimens can be processed, maps, field notes, and other records held on file, and analytical work carried out for the preparation of full technical reports for publication; (2) preliminary surveys to locate all possible antiquities within specific reservoir units; (3) limited test-excavations to determine which sites appear to be of primary importance; (4) a more intensive follow-up scheme of extended excavation at those sites whose size, comparative richness or uniqueness, depth of overburden, historical position, representativeness of a locality, or other characteristics promise particularly informative results in relation to the archeology and paleontology of neighboring districts and of the Basin as a whole; (5) the preparation and publication of complete technical reports and nontechnical accounts of the findings; and (6) the proper disposition and preservation of specimens, records, and other basic data that may be collected.

To finance the beginning field surveys, funds were allotted by the Bureau of Reclamation to the Smithsonian Institution through the National Park Service. The sum of $20,000 was made available in fiscal 1946, and this has been augmented by an allotment of $40,000 for fiscal 1947. By agreement, these funds are to be used on Corps of Engineers as well as Bureau of Reclamation projects.

On July 8, 1946, the writer left Washington for Lincoln, Nebr., to set in motion the first phases of the program. Through the courtesy of officials and members of the teaching staff of the University of Nebraska, a field office was established at the university's Laboratory of Anthropology. At present, this office and the project laboratory are located in the basement of Love Memorial Library on the campus. In addition to the immediate availability of adequate quarters and facilities where there was already an active anthropological laboratory, consideration was given to Lincoln's proximity to the regional office of the National Park Service and the Division office of the Corps of Engineers, both in Omaha; to the fact that excellent library and museum facilities, as well as professional consultants in a variety of specialized fields, were close at hand; and to the Cross-Cultural Survey on several Missouri Basin tribes now being carried on here jointly by the University of Nebraska and Yale University.

The professional staff of the Missouri River Basin project now includes 6 full-time archeologists: Paul L. Cooper, acting field director during such periods as the writer's official duties keep him in Washington; Robert B. Cumming, Jr., laboratory supervisor; Wesley L. Bliss, Marvin F. Kivett, J. Joe Bauxar, and Jack T. Hughes. There is also one expert laborer, J. M. Shippee; and a temporary office assistant. Plans are under consideration for adding one or more paleontologists, as needed, and such laboratory help as may be required from time to time. This staff has been set up in accord with Civil Service Commission procedure. It will engage in field work during the summer, and in laboratory research and preparation of reports during the winter. Through these reports, both technical and nontechnical, the Survey findings will be made available to the interested public. Preliminary reports on the 1946 work are currently in preparation. The specimens collected will be divided after they have been studied, with representative collections of type specimens deposited in the United States National Museum; another type series will be placed in Recreation Area exhibits where such are established; and the remaining materials will be deposited in various functioning State and local institutions. The basic records of the work will be permanently filed at the Smithsonian Institution, and the completed scientific reports will be published in one of the regular Smithsonian publication series.

Actual field work by the Survey began on August 3, 1946, with preliminary investigations at 28 top-priority Bureau of Reclamation projects and 6 Corps of Engineers units. Inadequate transportation facilities combined with the lateness of the season and consequent need for prompt departure restricted the size of the three survey parties to two men each. In each reservoir visited, project engineers, surveyors, and other personnel were consulted, and the area was then searched as thoroughly as the available time permitted. Because the work was done so late in the summer, maturing crops and grass cover made surface-collecting and the delineation of sites particularly difficult. It is expected that more leisurely surveys, made at a more favorable time of the year, will disclose a great many additional sites. The work of this initial reconnaissance, it should be noted, was very greatly expedited by splendid cooperation from Reclamation and Engineers project personnel, National Park Service, State universities, historical societies, the United States Geological Survey, the Fish and Wildlife Service, and other interested agencies and individuals throughout the Basin.

Projects visited in the preliminary reconnaissance included Kanopolis, Cedar Bluff, and Kirwin, in Kansas; Harlan County, Medicine Creek, Enders, and Box Butte, in Nebraska; Wray and Cherry Creek, in Colorado; Glendo, Kortes, Lake Solitude, Boysen, Anchor, and Oregon Basin, in Wyoming; Yellowtail, Canyon Ferry, Tiber, and Medicine Lake, in Montana; Angostura, Deerfield, Blue Horse, Shadehill, and Fort Randall damsite, in South Dakota; and Heart Butte, Dickinson, Broncho, Jamestown, Devils Lake, Sheyenne, Crosby, and Garrison damsite, in North Dakota. In addition, the writer, incidental to other tasks, briefly inspected several important sites at the proposed Oahe damsite, others at old Fort Bennett, and one above Mobridge, all in South Dakota. Some understanding of the vastness of the area under investigation may be gotten from the fact that more than 13,000 miles of motor travel were involved in this preliminary work. Missouri, where several large Corps of Engineers projects are pending, was not visited in 1946.

A period of approximately 8 weeks was devoted to the 1946 reconnaissance; its results must be characterized as extensive but attenuated rather than intensive. It is apparent nevertheless that a task of major proportions is before us. No less than 170 sites, many of them hitherto unreported, were located and recorded; some of them have already been partially destroyed by construction work. At most reservoir units, additional surveys have been recommended by the field investigators, since complete coverage of the future pool area was in no case possible. It is expected that the number of additional sites will far exceed those recorded to date. Deerfield, Dickinson, Kortes, and Lake Solitude can probably be written off so far as archeology and paleontology are concerned; Kirwin and Wray will require very little further attention. It should be added, however, that negative diagnoses are in all cases subject to change when actual earth-moving operations begin.

The survey findings to date, in briefest outline, indicate that the Wyoming-Montana area includes comparatively few pottery-bearing sites. Here, as in the western Dakotas, boulder circles or "tipi-rings" occur in great numbers. There are also numerous outcrops of artifact- and refuse-bearing strata several feet beneath the present land surface, exposed by stream-cutting; and several of these give promise of containing remains assignable to early, perhaps paleo-Indian, occupations. Hearths exposed by wind erosion, caves, and rock shelters, as well as reported bison falls, await further investigation.

In northern Kansas and southwestern Nebraska, pithouse villages attributable to semisedentary horticultural peoples predominate. Test excavations at Harlan County reservoir, already in construction status, have disclosed a prehistoric ossuary, with possibly associated village sites nearby. In this unit, too, village sites belonging to at least four distinct archeological horizons will be inundated; and further excavation will certainly have to be done. In Medicine Creek and Harlan County units important fossil deposits lying in the future pool areas will also require attention.

On the tributaries of the Missouri in North and South Dakota, pottery-bearing sites occur scatteringly, as well as "tipi-rings." In the Jamestown-Devils Lake-Sheyenne area east of the mainstem are mound groups, village remains, and campsites suggesting a more sedentary occupation than that west of the Missouri. These and other units of the far-flung Missouri-Souris project will entail continuing vigilance throughout the continuation of the developmental work.

Not included in the above count are approximately 300 village sites reported, but not yet visited by the survey, along the mainstem in the Dakotas. Here are some of the largest, best-preserved, and most impressive Indian townsites in the United States. They contain much of the story of the development of Arikara, Mandan, and other upper Missouri cultures. Their relationship to pottery sites on the tributaries to east and west is still obscure. Limited excavations before the war constitute only a sampling of the field; and in comparison with what needs to be done, they represent little more than scattered match-flares of knowledge in a twilight of archeological ignorance. Their ultimate destruction will efface forever a substantial part of the basic material of human history in what has been aptly called one of the four major archeological areas north of Mexico.

The locating of sites, obviously, is only the first step. Actual excavation is needed to determine the identity of the people who left the remains and the way they lived. The immediate problem therefore is to evaluate the findings of the preliminary survey, and to determine which sites should be further tested or extensively excavated. Since we cannot hope to evacuate all of the sites that will be destroyed, it will be necessary to limit our excavation program to a few truly representative or otherwise particularly promising locations, in the further hope that time may also be available for sampling some of the less promising. In short, we shall have to strike a balance between the work that ought to be done, and the work for which there may be time and means.

It is expected that the excavation program will be coordinated with the construction schedule of the Bureau of Reclamation and the Corps of Engineers. Additional survey work is needed, however, before a long-range archeological program of any preciseness can be set up. It is contemplated, therefore, that the work for the calendar year 1947 will consist of the following survey operations:

(a) Additional surveys in those reservoirs listed above as having archeological and paleontological potentialities, with limited test-pitting of a number of sites in each unit.

(b) A thorough reconnaissance of the mainstem in South Dakota, with emphasis on the topographic mapping of sites showing such surface features as house pits, defensive works, middens, etc., and on correlated test-pitting and collecting of sample remains. This mainstem work cannot be long delayed; the Fort Randall dam a few miles above the Nebraska-South Dakota line, which will flood 100 miles of the Missouri valley, is in construction status; the Oahe dam above Pierre, which will flood upward of 150 miles of the valley, is only a little more remote. The detailed survey of both reservoirs will be a time-consuming and arduous task—but one that also promises important scientific returns.

It is believed that the consummation of the foregoing steps, together with the advice of experienced workers in upper Missouri Valley archeology, will enable us in another year to select those few key sites which it may be possible to investigate thoroughly in the various project units.

In addition, it is proposed that excavations be undertaken at certain immediate trouble spots. For this purpose, funds are being requested for investigations in 1947 at Angostura Reservoir, on Cheyenne River in southwestern South Dakota; at Boysen Reservoir, now under construction on Bighorn River in west-central Wyoming; and at Heart Butte, on Heart River in west-central North Dakota. The Boysen unit presents both archeological and paleontological problems; Angostura and Heart Butte at present are of archeological interest primarily.

It is expected further that if Oahe dam reaches construction status in 1947 funds will also be requested for excavation of two well-preserved fortified village sites nearby which will almost certainly be destroyed by, or as a result of, construction activities. At Fort Randall and Garrison damsites there appears to be no immediate need for large-scale salvage work on Indian remains.

It should be apparent that the scientific recovery operations now under way in the Missouri River Basin are a race against time. From the viewpoint of the archeologist, the work can be considered ended only when the rising waters finally submerge the archeological and paleontological sites, or when construction of dams, spillways, and canals destroys them. The scale of the investigations must be limited only by the means and personnel available.

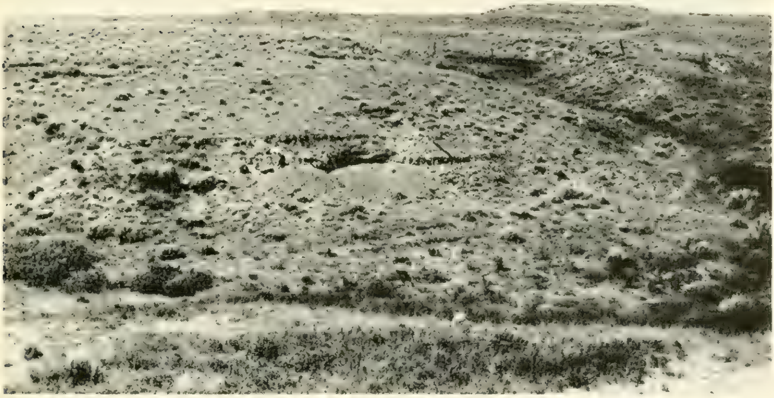
It ought to be evident, too, that in this work of salvage there must be no holding back by State, local, and other non-Federal agencies and organizations interested in Missouri River Basin prehistory. Federal participation in the task may be taken as recognition of the fact that the Missouri Valley program has outgrown private and State enterprise; that the Government, whose planning will be responsible for mass destruction of archeological, paleontological, and historical remains, assumes a measure of responsibility for their partial recovery and preservation. Unlike many of their sister States, some of those in the Basin have been slow to develop their archeological and other scientific materials; none has the trained personnel or the resources to cope single-handed with the task ahead. It is the full intention of the Smithsonian Institution and the National Park Service to encourage the participation of State and local organizations in the survey program and to utilize their advice and assistance wherever competent personnel and facilities are available. Consultations for this purpose have already been held; more are in prospect. It is a heartening sign of growing public interest when an overcrowded State university places office, laboratory, and storage space at the disposal of the Survey; when other universities and historical societies undertake to raise funds, or to re-allocate present funds, to participate in the work; when responsibility for investigation of particular units of the developmental program is assumed by qualified State agencies so that the Federal efforts may be concentrated on other deserving projects; and when national scientific organizations such as the Society for American Archeology, the American Anthropological Association, and the American Council of Learned Societies jointly establish a cooperating Committee for the Recovery of Archeological Remains. There can be no thought that the Federal Government should do the whole Basin-wide job unaided. At the same time, because the scientific problems—like the over-all plan of river valley development—transcend State boundaries, it is essential, in order to assure the fullest coordination of effort on a regional scale, that central direction of the recovery program be established and retained in a single agency of the Government—a responsibility that now rests by agreement with the Smithsonian Institution.

The archeological, historical, and other scientific materials in the Missouri River Basin are of far more than merely local or State interest. In many sites there is evidence of a succession of prehistoric floods, of silting and soil erosion, of recurrent droughts and climatic fluctuations, and these should throw light on modern problems arising from similar phenomena. The archeological record of land utilization, of the specialization of corn and other domestic food crops, and of shifting population distributions under varying environmental and economic conditions may add basic information to our comprehension of modern settlement problems. The human skeletal material taken from archeological sites may be expected to contribute to medical science added records, as evidenced in bone pathology, of prehistoric diseases that ran their course untreated. The archeological materials, no less than the historical and paleontological resources of the Basin, in short, are national assets.

Within the far-flung boundaries of the Missouri Biver Basin occurs a wide variety of climatic and topographic conditions; cultural remains already found range from some as early as anything yet reported in the Americas to the Indians who were finally dispossessed by the white man. Viewed in this light, the possibilities inherent in a sustained, comprehensive, and unified Basin-wide program of archeological investigation seem obvious. Even with such practical limitations as may be enforced by the general developmental program, there is still a rare opportunity to attack scientific problems of native cultural development in time and space throughout a vast and important region of the interior United States. Properly done, such a program cannot fail to add materially to the story of the people who preceded the white man in the New World. Just as the welfare of the present-day residents of the Basin is interwoven with that of peoples far beyond its limits, so its prehistory is part of a larger story of man's evolution and cultural development. It is the recovery, preservation, and interpretation of such of the threatened irreplaceable basic data as time and means permit that comprises the work of the Missouri River Basin Survey.

1. Test Excavations at Lindenmeier Site in Northern Colorado

Figure in central foreground stands on old surface of Folsom occupation; estimated antiquity 10,000-25,000 years. (Photograph by F. H. H. Roberts, Jr.)



2. Excavating a Bison Kill of the Yuma Period South of the Proposed Edgemont Reservoir, in Eastern Wyoming

(Photograph by F. H. H. Roberts, Jr.)

1. BUFFALO PASTURE SITE, A FORTIFIED PROTOHISTORIC ARIKARA VILLAGE IN STANLEY COUNTY, S. DAK.

Situated just above the upstream toe of the proposed Oahe dam, this and many other sites face destruction by the reservoir waters.

2. FORT SULLY SITE, AN UNFORTIFIED PROTOHISTORIC ARIKARA VILLAGE IN SULLY COUNTY, S. DAK.

Dark circular depressions along the bluff top indicate former earth-covered lodge sites.

SMITHSONIAN MISCELLANEOUS COLLECTIONS
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THE INSECT CRANIUM AND THE "EPICRANIAL SUTURE"

BY

R. E. SNODGRASS
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U. S. Department of Agriculture

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CONTENTS

INTRODUCTION

The structure of insects presumably remains the same for long periods of time. A reading of entomological texts and papers, however, might give the impression that a rapid change has been going on in insects even during the last few years. The evident stability of the insect structure as compared with the diversity in the written accounts of it simply illustrates the difference between anatomy and morphology. *Anatomy* refers to the facts of structure, *morphology* is our interpretation of the facts or what we think about them. Anatomy is unchangeable, except by the slow processes of natural evolution; morphology, on the other hand, changes with each generation of morphologists, or as often as any morphologist changes his mind or thinks he sees a new light on an old subject. Sometimes the light is deceptive, what appears as reality to one may be a mirage to another. At best, morphological interpretations can be deduced only from circumstantial evidence, and evidence is not *circum*stantial if it is one-sided.

Students of entomology have long been taught that one of the most important structural features of the insect head is a Y-shaped line on the face called the "epicranial suture." Now a paper appears (DuPorte, 1946) in which it is asserted that this "suture" has no structural significance at all, being merely a line of weakness in the head wall where the cuticle splits at ecdysis, with its arms taking quite different courses in different insects. At the same time the same idea had been elaborated in the manuscript and drawings of the present paper. The two papers are in entire agreement concerning the "epicranial suture"; in other ways they are not completely in accord. DuPorte discredits the value of muscle attachments as criteria for determining homologies of parts in the exoskeleton; he says, "the known inconsistency of muscle origins throws doubt on their value in determining the homologies of the facial sclerites." However, one unreliable member of a class does not discredit the integrity of all the others. On the face of the insect are attached two groups of muscles, separated by the frontal ganglion and its brain connectives. There is no known irregularity in the relation of these muscles to the facial wall of the head, those of one group never invade the territory of the other group. Wherever the claim is made that there has been a shift in the origins of these muscles it will be found that the claimant has merely changed the name of the external part on which the muscles are attached. The writer, therefore, contends that the facial muscles of the insect head *are* reliable criteria for determining the homologies of the surface parts of the cranium. The frontal ganglion, moreover, is an important landmark in the fundamental anatomy of the head, and the structure of the head is not to be understood from a study of its superficial features alone. A man may be characterized by the wrinkles on his face, but probably there is an underlying reason for the wrinkles.

I. GENERAL DISCUSSION

The *cranium* of an insect is the sclerotized cuticle of the head. In discussing *sutures* it must be understood that an anatomical "suture," according to the literal sense of the word (from L. *suere,* to sew), should be a line along which two parts have united without obliterating the evidence of their union. The best examples of anatomical sutures, except those made by surgeons, are the irregular lines of junction between bones of the vertebrate skull, which to the earlier anatomists suggested seams of stitching. In entomology the term "suture" is carelessly used for any external groove of the integument, regardless of its nature or of how it may have been formed.

Since the integument of an animal is continuous over all parts of the body in postembryonic stages, the term "suture" can be applied only to lines of union between separate centers of dermal hardening. Thus, Ferris (1942), in discussing the head of Symphyla, says of the cranial lines that they "are sutures in the strictest application of the term, being seams between the various areas of sclerotization." However, by what evidence he arrives at this positive information he does not tell us. It is probable that the postoccipital sulcus of the insect head is a line of union between primitive segments, and on the ventral side of the head of some insects there are lines which clearly indicate the union of primarily separate sclerotic areas. Otherwise there is no proof that any of the lines on the insect's cranium are true sutures; neither nymphs nor larvae show separate centers of sclerotization in the head integument, and the embryonic head is unsclerotized. Certainly most of the so-called "sutures" of the insect head are grooves incidental to the formation of ridges on the inner surface, and these endoskeletal ridges are structural features serving to strengthen the cranial walls. The external grooves, or *sulci,* of the endoskeletal ridges, therefore, are not "sutures" in any true sense. Strenger (1942), in a "functional analysis of the orthopteran head," though calling these sulci "sutures" (Nähte), concludes that they are in general strengthenings along lines of stress in the head capsule.

There is, however, on the head of nearly all immature insects, and on that of some adults, another kind of line which is not marked by a groove externally, nor does it ordinarily form a ridge on the inner surface. This line is that commonly known as the "epicranial suture." Typically it has the form of a Y, inverted if viewed from in front. The stem, called the "coronal suture" or "metopic suture," is median on top of the head; the arms, or "frontal sutures," diverge laterally and downward to different points on the face in different insects. Functionally this "epicranial suture" is the line along which the head cuticle of the immature insect splits at ecdysis. It is in no sense a suture, and is here termed the *ecdysial cleavage line of the head.* DuPorte (1946) calls it the "ecdysial line or suture." In nymphal and larval stages the cleavage line usually appears as a pale double-edged tract of the head cuticula, the stem of which is continuous from the similar mid-dorsal line on the thorax. According to Duarte (1939) the line along which the cuticle splits on the thorax of *Locusta* is characterized by an absence of the exocuticular sclerotization, and a great elongation of the sublying epidermal cells. DuPorte (1946) says, "the ecdysial suture is a narrow line along which the sclerotic and usually pigmented exocuticle is not developed." The cleavage line, furthermore, is distinguished from other lines of the head in that of itself it does not form internally a ridge. However, as shown by DuPorte, the coronal stem of the cleavage line sometimes runs along the bottom of a ridge-forming sulcus, and thus has been confused with a coincident but independent structure.

It is generally observed that when the cuticle splits preceding ecdysis, the rupture appears first on the thorax, whence it proceeds anteriorly through the neck onto the head, where it forks (fig. 1 A); posteriorly the cleft may branch laterally behind the metathorax, or it may continue into the abdomen. Incidentally it should be noted that moulting and ecdysis are not the same thing. *Moulting,* with arthropods, is the separation of the old cuticle from the new cuticle formed beneath it; *ecdysis* is the emergence of the insect from the moulted skin. Ecdysis does not always accompany moulting, as when the larval cuticle forms a puparium. The cleavage line of the cuticle that opens to permit the escape of the insect is, therefore, a *line of ecdysis,* but not a "moulting line."

In some of the ametabolous and hemimetabolous insects the exuvial cleavage line of the head is carried over entire or partially into the adult (fig. 4 A, B, D, *CL*). As observed by Strenger (1942) in Orthoptera, however, it would appear in most cases that the retained cleavage line has no mechanical significance in the imago. Among holometabolous insects it is doubtful if the larval line of ecdysis is ever fully present on the adult head; usually it is entirely suppressed, though Y-shaped grooves of internal ridges of the cranium that have no relation to the larval cleavage line have been regarded as the "epicranial suture." Examples of such misidentification will be given in the discussion of Coleoptera and Mecoptera.

The region of the face between and below the arms of the cleavage line includes the areas commonly known as the *frons,* the *clypeus,* and the *labrum.* The labrum, however, is the only anatomically distinct part of this region, since usually it is separated from the clypeal area by a flexible, membranous or weakly sclerotized conjunctiva, and generally it is movable by muscles arising on the frons. The frontoclypeal area presents in most insects a continuously sclerotized surface, though in many insects a transverse inflection, the *epistomal,* or *frontoclypeal, sulcus,* runs between the anterior mandibular articulations and forms a strong ridge on the inner surface. This groove, when present, separates the clypeal area from the frontal area, but it is clearly a secondary device for strengthening the head wall between the bases of the jaws, and, considering the irregularity of its occurrence, it may be suspected of having been independently developed in some cases. However, this epistomal sulcus lies posterior to the muscles that pertain to the clypeus, and separates these muscles from those which arise above it on the frons.

The frons is usually defined as the facial area above or behind the clypeus embraced by the arms of the "epicranial suture"; but, thus defined, it has no definite anatomical status because of the different courses followed by the said arms of the "suture" (fig. 1 C-G). According as the arms go behind or between the antennae, the "frons" in some cases carries the antennae, in others it does not, and this inconsistency is clearly seen on the head exuviae after ecdysis. DuPorte (1946), therefore, would bound the frons laterally by grooves present in some insects extending dorsally from the anterior mandibular articulations. These lateral grooves, however, in some insects run laterad of the antennae and in others mesad of them, and in many cases the "frontogenal sulcus" of DuPorte is part of the groove commonly known as the frontoclypeal, or epistomal, sulcus. In short, the "frons" is a name rather than an anatomical reality, but as a name without a definition it is perhaps the more useful inasmuch as any writer may apply it as he chooses. In the present paper the term *frons* is used in an indefinite sense for the facial area of the head above the clypeus, or the clypeal area, just as *vertex* applies to the top of the head, and *genae* to the sides. The areas designated by these names are topographical but not anatomical. When the arms of the cleavage line go posterior to the antennae (fig. 1 C, D) they approximately define the frons; when the arms go between the antennae the area they embrace is frontal (F), or frontoclypeal (G), but is not *the* frons or *the* frontoclypeus. The part cut out at ecdysis may be termed the *apotome,* which will be either a *frontal apotome,* or a *frontoclypeal apotome,* according to the position and extent of the cleavage lines.

Riley (1904), in his account of the embryonic development of the head of *Blatta,* contended that the labrum, the clypeus, and the frons are all derived from the "procephalon" (meaning the preoral lobe of the embryonic head terminating with the labrum). "The vertex, the compound eyes, and with them the ocular sclerites and the genae," he says, "are formed from the fused cephalic lobes and thus, with the front, clypeus and labrum, belong to the ocular or protocerebral segment." The Y-shaped "epicranial suture" of the head, Riley claims, results from the dorsal union of the cephalic lobes (forming the coronal stem), and the inclusion within their anterior angle of the procephalic lobe (forming the divergent frontal arms). Other students of insect embryology have given the same explanation of the origin of the cleavage line on the head in orthopteroid insects, and it has been invoked by Steiner (1930) to explain the line in *Sialis,* though without any substantiating evidence. If the Y-line does thus originate, it may be regarded as a true suture.

The ecdysial cleavage line on the head, however, as it actually occurs in postembryonic stages, is much more variable than might be expected from a structure of fundamental significance. It varies with different insects in the point of forking on the face, the course taken by the arms, and the points at which the arms terminate. Thus, in some insects the clefts along the arms of the cleavage line at ecdysis cut into or through the compound eyes (fig. 1 C), in others they end between the eyes and the antennae (D), in still others they go to the antennal fossae (E), while again they run mesad of the antennae (F), and finally they may extend entirely through the clypeus (G). Also the coronal stem of the Y varies in length, and in some insects it is entirely absent (H), in which case the frontal clefts may proceed separately from the occipital margin of the cranium. On the other hand, the frontal arms in some insects are obsolete, and at ecdysis the coronal split extends to the clypeus, or to the labrum (I), cutting the head cuticle through the midline of the face.

Furthermore, the Y-shaped line of cuticular cleavage on the head is a feature peculiar to insects. If it represents so important a thing as the line of dorsal closure and union of the head components, it should be present also in other arthropods, but it is not—other arthropods have different ways of ecdysis. It seems probable, therefore, that at least the frontal arms of the cleavage Y are secondarily developed lines of weakness in the head cuticle, and hence are free to follow different courses in different insects. In any case, the embryonic dorsal closure of the head lobes, and that of the thorax as well, is purely an embryonic device for growing around the yolk, and cannot possibly represent any phylogenetic event in the evolution of the free-living ancestors of the insects, which presumably shed their skins as modern insects do.

Whatever may be the origin of the cleavage line on the insect head, however, and regardless of where the arms branch from the coronal stem or of the course they follow on the face, the arms are consistent in one respect, which is, that they invariably lie between two distinct sets of head muscles; at ecdysis the frontal clefts always separate the

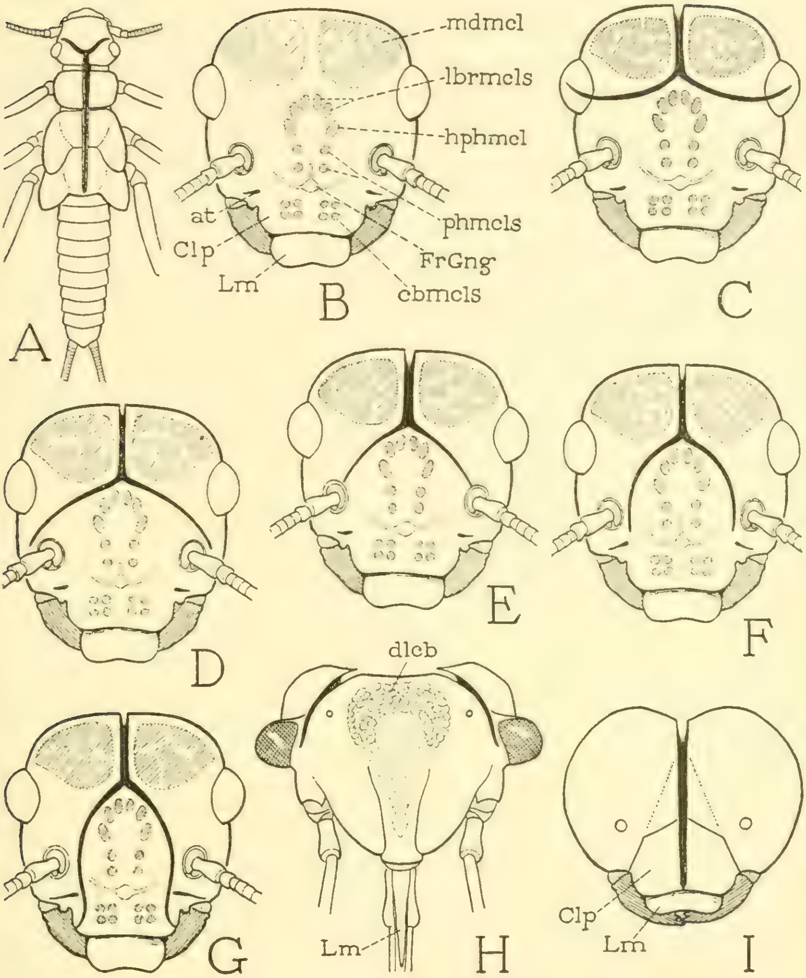

FIG. 1.—Diagrams showing the cleavage line of ecdysis, its principal variations on the head, and the relation of the frontal arms to the head muscles.

A, stonefly nymph showing entire cleavage line, with frontal forks on head. B, distribution of head muscles, with cleavage lines omitted. C, frontal splits at ecdysis extended into compound eyes. D, frontal splits going between eyes and antennae. E, frontal splits ending at antennal fossae. F, frontal splits going mesad of antennae. G, frontal splits extended to free margin of clypeus. H, coronal line absent, frontal splits proceeding separately from posterior margin of cranium (Pentatomidae). I, frontal arms of cleavage line obsolete, coronal split extended to labrum (Vespidae).

at, anterior tentorial pit; *cbmcls,* cibarial muscles; *Clp,* clypeus; *dlcb,* dilators of cibarium (*cbmcls*); *FrGng,* frontal ganglion; *hphmcls,* frontal muscle of hypopharynx (retractor of mouth angle); *lbrmcls,* labral muscles; *Lm,* labrum; *mdmcl,* mandibular muscle; *phmcls,* dilator muscles of pharynx.

region of the cranium on which arise the muscles of the maxillae and the mandibles (fig. 1 B, *mdmcl*) from that on which the facial muscles take their origin. The facial muscles comprise two distinct groups: an upper group, including the extrinsic muscles of the labrum (*lbrmcls*), except in adult Diptera, the precerebral dilators of the pharynx (*phmcls*), and the dorsal hypopharyngeal muscles (*hphmcl*), or "retractors of the mouth angles"; and a lower group of intraclypeal muscles, which are the dilators of the cibarium (*cbmcls*). The cibarial muscles are always separated from the hypopharyngeal and pharyngeal muscles by the frontal ganglion (*FrGng*) and its brain connectives.

In recent years it has become the custom, following Crampton (1932) and Snodgrass (1935), to give the name "postfrontal sutures" to arms of the cleavage line that diverge to points usually between the eyes and the antennae (fig. 1 D), while the term "frontal sutures" is restricted to the arms in positions mesad of the antennal bases (F). In either case, however, the divergent arms of the "epicranial suture" on the head of an immature insect are the preformed lines of the future exuvial splits that branch from the end of the coronal cleft. As DuPorte (1946) has shown, the two supposed "sutures" are the same thing in different positions.

The idea that the arms of the cleavage line on the head are two different "sutures" according as they go laterad of the antennae or between them has led to some curious interpretations of the insect head structure. Ferris (1942), for example, calls the lines in the first case the "postfrontal sutures," and connects them with the temporal sulci that in some insects run back over the top of the head mesad of the compound eyes and then downward on the posterior surface to the bases of the mandibles. The continuous line thus established he calls the "great suture" of the cranium, which he asserts is the line of union between the oculoantennal segment and the mandibular segment of the head, the tritocerebral segment being assumed to have been obliterated. The mantis is cited as an example demonstrating this alleged continuity in the parts of the "great suture," and, in fact, on the head of an *adult* mantis (fig. 4 D) the arms of the cleavage line (*CL*) do appear to turn back and become continuous with the temporal sulci (*ts*). The continuity, however, is not present in the nymph, and even in the adult the external appearance is misleading.

An examination of the inner surface of the adult mantid cranium (fig. 4G) shows that the facial area is fortified by a complex of ridges braced laterally against the circumocular ridges (*OcR*) and continued dorsally into the temporal ridges (*TR*). From the lower end of each temporal ridge a short branch (*d*) extends mesally along the frontal arm of the persisting nymphal line of ecdysis (*CL*). The exuviae of a nymphal mantis (*F*), however, show that in the immature insect the facial ridges are much less developed than in the adult; there is here no trace of the branches from the temporal ridges invading the arms of the cleavage line, and even in the last nymphal stage the temporal sulci themselves (F, *ts*) do not reach the latter. In the first instar nymph (E) the temporal sulci end far short of the arms of the cleavage line, which are pale soft tracts of the head cuticle leading directly to the eyes. The frontal arms of the cleavage line are thus unencumbered in the nymph; at ecdysis (F) the frontal splits extend through them unobstructed, and furthermore, at least at the final ecdysis, they cut through the middle of the compound eyes (*E*).

The structure in the mantis on which Ferris bases his concept of "the great suture" is thus seen to be one that pertains only to the imago, which, being done with moulting, can undergo a structural remodeling without regard to ecdysis. If the apparent continuity of the cleavage lines and the temporal sulci in the adult mantid were real and of such fundamental structural importance as Ferris contends, the unity of the lines should be all the more evident in the nymph. Among other species of insects given by Ferris to illustrate his "great suture" he nowhere is able to find an actual continuity between the "postfrontal sutures" and the "temporal sutures," and, as will be shown later, in his discussion of the head of the symphylid *Scutigerella* he is forced to compose a "great suture" from ingredients that are not sutures at all and have no relation to one another.

The area below the so-called "postfrontal sutures," or arms of the cleavage line extending laterad of the antennal basis (fig. 1 D), is regarded by Ferris (1942) as the "frons," or later (1943) as the "antennal segment"; but when the arms go downward on the face between the antennae (F, G), as they do in most holometabolous larvae, they are together identified as the "clypeofrontal suture," and the facial area embraced by them is interpreted as that of the clypeus extended upward on the face. Yet if the cleavage lines were deleted (fig. 1 B) there would be no evident differences in the structure of the head in the two cases. The cranial muscles have always the same relative distribution, as is amply shown by Cook (1944) in his comparative study of the labral and clypeal muscles in the principal orders of insects, though Cook follows the Ferris interpretation of the skeletal areas of the head. The facts represented diagrammatically on figure 1 (C-G) show that the frontal arms of the cleavage line simply take any position in the otherwise unoccupied spaces between the mandibular muscles and the facial group of frontoclypeal muscles. The shift in the lines from one position to another affects the manner of ecdysis, but the cranial structure is thereby no more altered than is an orange changed in structure according to the way it is peeled.

An understanding of the structure of the insect cranium must take into consideration certain facts in the basic organization of the head. Though the frons and the clypeus present externally a continuous surface, which may be indented by an epistomal sulcus for purposes of reinforcement, a real anatomical difference between the two areas arises from the fact that, while the frons is a part of the postoral anterior wall of the cranium, the clypeus, in its generalized state, is *preoral,* since it is the basal part of a hollow lobe projecting in front of the mouth (fig. 2 D) divided into clypeus (*Clp*) and labrum (*Lm*). Both the labrum and the clypeus, therefore, have an outer surface and an inner "epipharyngeal" surface. Each has a set of internal compressor muscles (*cprlm dlcb*), and the movable labrum has muscles (*lbrmcls*) arising on the frons. On the frons are attached also, as above noted, the precerebral dilators of the pharynx (*dlphy*), and a pair of muscles (*hphmcl*) inserted on the oral arms of the suspensory apparatus (*HS*) of the hypopharynx (*Hphy*). Since the clypeal muscles and the frontal muscles are invariably separated by the frontal ganglion (*FrGng*) and its brain connectives, this fact would seem to have some important significance bearing on the fundamental structure of the head.

The frontal ganglion in its embryonic origin is derived from the dorsal wall of the ectodermal stomodaeum just within the mouth; its nerve connections are with the tritocerebral lobes of the brain (fig. 2 A, *T*). The tritocerebral brain lobes, however, as shown by phylogeny and embryogeny, have been added secondarily to the primitive suprastomodaeal brain, which included only the ocular and the antennal centers (A, *P, D*) that become the protocerebrum and deutocerebrum of the definitive brain. Primarily the tritocerebral lobes (A, *T*) were the ventral ganglia of the premandibular somite (B, *GngI*). If, therefore, the head ganglia are visualized as they would be if restored to their primitive places (B), it is clear that the frontal ganglion (*FrGng*) must have been an unpaired, or possibly paired, preoral center of the ventral nerve cord with its connectives from the premandibular ganglia (*GngI*) embracing the stomodaeum just within the mouth. With the later transposition of the premandibular ganglia to the brain (A), of which they constitute the tritocerebral lobes (*T*), they carry the frontal-ganglion connectives with them, but the ganglion itself maintains its primitive position.

The frontal ganglion, therefore, always marks the dividing line between the under surface of the preoral clypeus and the postoral part

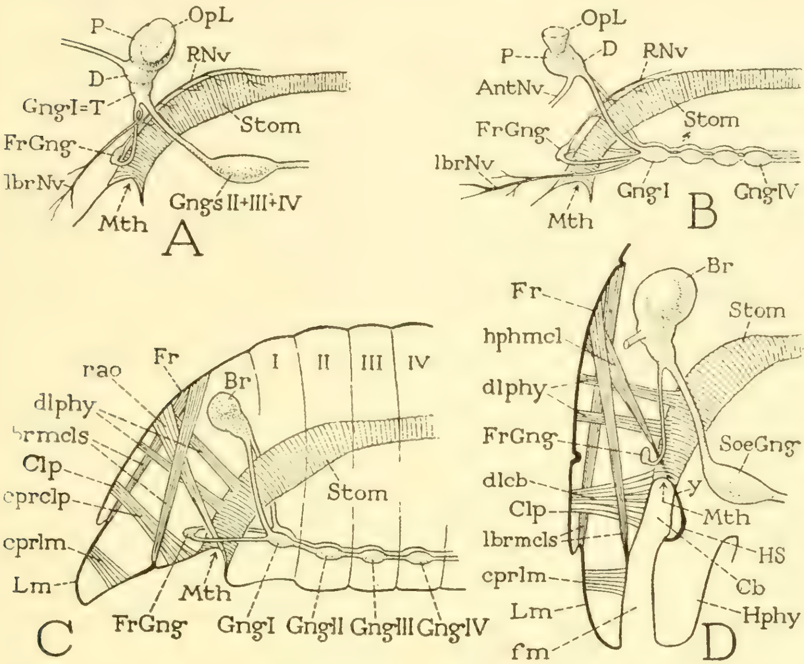

Fig. 2.—Diagrams showing the relation of the facial muscles to the frontal ganglion in the definitive structure, and in a theoretically primitive state.

A, definitive structure of the head nervous system; first postoral ventral ganglia (B, *GngI*) have become tritocerebral lobes of brain (*T*), the three following ganglia united in the suboesophageal ganglion. B, primitive relations of the same parts: the definitive tritocerebral ganglia (*GngI*) are postoral, the frontal ganglion (*FrGng*) is a preoral ganglion of the ventral nerve cord. C, theoretical facial musculature with primitive nervous system as at B. D, the same muscles as at C, with definitive nervous system as at A.

AntNv, antennal nerve; *Br*, brain; *Cb*, cibarium; *Clp*, clypeus; *cprclp*, compressor muscles of clypeus, prospective dilators of cibarium; *D*, deutocerebrum; *dlcb*, dilators of cibarium (compressors of clypeus); *dlphy*, dilator muscles of pharynx; *fm*, food passage; *Fr*, frons; *FrGng*, frontal ganglion; *GngI*, ganglia of first postoral somite (definitive tritocerebral lobes of brain); *GngII, III, IV*, ganglia of second, third, and fourth postoral somites; *hphmcl*, frontal muscle of hypopharynx (same as C, *rao*); *Hphy*, hypopharynx; *HS*, hypopharyngeal suspensorium; *I-IV*, first four postoral somites; *lbrmcls*, labral muscles; *lbrNv*, labral nerve; *Lm*, labrum; *Mth*, mouth; *OpL*, optic lobe; *P*, protocerebrum; *rao*, retractor muscle of mouth angle, frontal muscle of hypopharynx (D, *hphmcl*); *RNv*, recurrent nerve; *SoeGng*, suboesophageal ganglion; *Stom*, stomodaeum; *T*, tritocerebrum; *y*, oral arm of hypopharyngeal suspensorium.

of the head (fig. 2 D), and it maintains its primitive oral association regardless of whatever position the mouth may take by invagination within the head.

In the primitive condition of the nervous system, accompanied by what may be supposed to have been the primitive musculature of the anterior part of the head (fig. 2 C), the frontal ganglion (*FrGng*) must have lain between the compressor muscles of the clypeus (*cprclp*) and the postoral group of frontal muscles. The latter included dilators of the pharynx (*dlphy*), and possibly a pair of retractors of the mouth angles (*rao*). The clypeal compressors become in the modern insect (D) the dilators of the cibarium (*dlcb*), and, with the development of the hypopharynx, the mouth-angle retractors become the muscles of the hypopharyngeal suspensoria (*hphmcl*). In generalized pterygote insects the frontal muscles of the hypopharynx are functionally productors of this organ, but they are retained in Neuroptera, Coleoptera, and Hymenoptera, in which the hypopharynx is intimately united with the labium (fig. 13 A, F) and has no independent movement.

The development of the insect hypopharynx (fig. 2 D, *Hphy*) from a metastomial lobe of the head creates a food passage (*fm*) leading to the mouth between the inner wall of the labrum and clypeus and the anterior wall of the hypopharynx. At its inner end the food passage is usually enlarged by a depression of the hypopharyngeal surface to form a food pocket, the cibarium (*Cb*), beneath the clypeus. The pocket, therefore, may be expanded by the contraction of the compressor muscles of the clypeus, which thus become dilators of the cibarium (*dlcb*) ; it is compressible either by transverse muscles on the clypeal wall, or by elasticity of the latter. The cibarium is therefore capable of a sucking action, and in the liquid-feeding insects it is elaborated into a highly efficient ingestion pump.

With the greater development of the cibarial pump, the clypeal dilator muscles become greatly increased in size, and, to accommodate these muscles, the outer wall of the clypeus is correspondingly enlarged by an upward extension on the face. There is thus always a close correlation between the size of the clypeus and the size of the pump muscles, and in most of the insects that feed exclusively on liquid food the clypeus, or the clypeal area of the head wall, occupies a relatively large part of the facial surface of the cranium. If the clypeus is not set off from the frons by an epistomal sulcus, its proper area is always to be identified by the origins of the dilator muscles of the sucking pump, and in no such case is it necessary to suppose that the clypeus in its upward or posterior extension has taken over the muscles of the invaded frons.

II. EXAMPLES OF THE ECDYSIAL CLEAVAGE LINE OF THE HEAD

Though the Y-line of the ecdysial cleft on the head is well known under the name of the "epicranial suture," a few examples taken from the principal orders of insects will serve to show its variations, which have not been given much consideration by entomologists. Also, it will be noted that grooves of secondary cranial ridges present in larval or adult stages of some insects have been misinterpreted as the "epicranial suture."

The names of genera and species used in the following descriptions have been furnished by the entomologists in the United States National Museum; the names of authors of species not given in the text will be found in the legends of the figures.

Apterygote insects.—Only a few published records are to be found on the manner of ecdysis in Protura, Collembola, Diplura, and Thysanura. Henriksen (1932) has shown that in the machilid *Petrobius balticus* Stach a rupture takes place along the midline of the back of the thorax and is continued on the head, where it ends behind the eyes in a pair of very short lateral branches. At ecdysis of the silverfish *Ctenolepisma longicaudata* Esch., Lindsay (1940) says, "a deep furrow develops in the mid-dorsal line of the thorax and along the epicranial stuture." In a personal communication to the writer, Charles L. Remington, of Harvard University, describes the exuvial split observed by him in a specimen of *Campodea* as extending from the neck upon the head as far as the bases of the antennae. Concerning ecdysis in Collembola, Handschin (1926) records that in *Onychiurus armatus* Tulb. the skin is split between the head and the thorax by alternate dorsal and ventral bending of the body; in some other species, however, he says the exuviae are not shed entire, but break up into fragments which in the course of time are rubbed off. Davis and Harris (1936), in their study of *Pseudosinella violenta* (Folsom), an entomobryid, observe merely that the insect moves the thorax up and down until the old skin begins to split along the mid-dorsal region of the thorax. Exuviae of the podurid *Achorutes* examined by the writer show the skin to have been shed in one piece, and that the insect emerged through a rent on the back of the thorax extended on the head, where it appears to be forked above the bases of the mouth parts.

From these few records it would appear that ecdysis in most of the apterygote insects takes place generally as in Pterygota through a cleft on the thorax and head, but that the frontal arms of the cleavage line are short or absent. The Protura and Diplura commonly have an internal median ridge along the posterior part of the head. Though Tuxen (1931) in reference to Protura points out that this ridge is an apodemal structure quite unlike the thin line of ecdysis in pterygote insects, it is still possible that its component lamellae may be split apart at ecdysis.

Ephemeroptera and Plecoptera.—In these two orders the line of exuvial cleavage is plainly marked on the larval head, and has the typical Y-form (fig. 3 A, B, *CL*). The frontal arms diverge to points between the eyes and the antennae, and may therefore be said to delimit the frons (*Fr*). At ecdysis the head cuticle splits to the ends of the frontal lines, as shown in the plecopteron *Acroneuria* (C).

Odonata.—The cleavage line on the head of larval Odonata is characteristically T-shaped rather than Y-shaped, inasmuch as the frontal arms usually go almost straight laterally (fig. 3 D). According to Calvert (1934) in the first larval exuviae of *Anax junius* the transverse fissure does not reach the eyes, as in following ecdyses; the median fissure, however, extends apparently to the labrum, so that the two clefts form a cross on the top of the head. On the exuviae of subsequent instars the frontal arms of the cleavage line cut through the corneae of the compound eyes, but Calvert says the point at which they enter the corneae moves forward during larval development. While with most dragonflies the exuvial cleft at the last ecdysis cuts the cornea into an upper and a lower section (fig. 3 E, F), Calvert observes that "in at least some Libellulidae it cuts through the side of the head anterior to the eyes and in some members of this family (e. g., *Macromia, Plathemis*) farther cephalad than in others (e. g., *Libellula, Sympetrum*)." Henriksen (1932) says the cleavage line is easily seen on the eye of an odonate larva, but the writer has discovered no trace of it on the eyes of specimens examined before ecdysis.

Dermaptera.—The Y-line of cuticular cleavage on the head in this order is as plainly marked in the adult (fig. 4 A, B) as in the nymph. In *Anisolabis maritima* (A) the arms of the cleavage line curve outward and forward to the mesal angles of the eyes, where they are met by the lines of internal ridges extending upward laterad of the antennal sockets, but the writer has no examples of the splits as formed at ecdysis in this species. In *Forficula auricularia* also the arms of the cleavage line go to the compound eyes (B), and at ecdysis, as noted also by Henriksen (1932), the cuticular splits bisect the corneae (C). The frontal apotome (*frapt*) of the exuviae is then turned forward and downward, widely opening the corneal cleft,

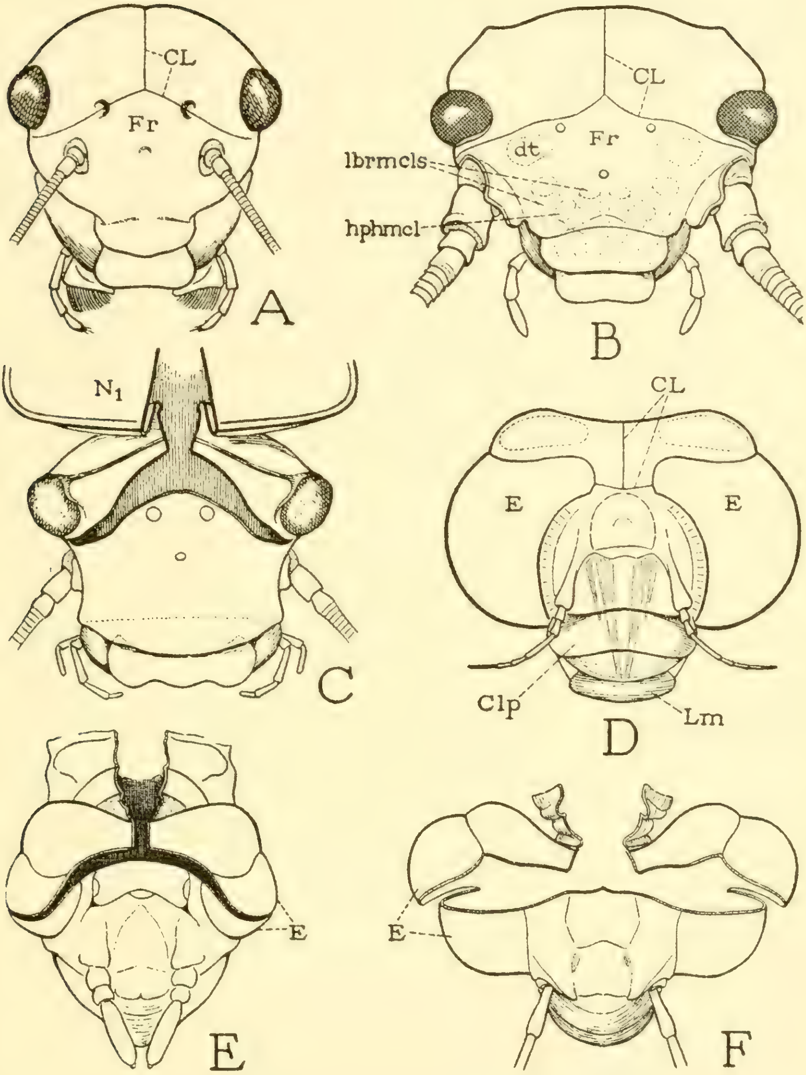

FIG. 3.—Ephemeroptera, Plecoptera, and Odonata.

A, ephemeropteron, head of larva. B, *Pteronarcys* sp., Plecoptera, head of larva. C, *Acroneuria* sp., Plecoptera, exuviae of head and prothorax. D, *Anax junius* (Drury), Odonata, head of larva. E, *Opisthogomphus morrisoni* Selys., Odonata, exuviae of head and prothorax. F, *Archilestes californica* McL., Odonata, exuviae of head.

while the mouth parts and antennae project posteriorly beneath the skin of the head.

Orthoptera.—Most of the Orthoptera retain at least a part of the cuticular cleavage line in the adult, though neither in the imago or the nymph do the arms always represent the full length of the exuvial splits that take place at ecdysis.

In the Mantidae (fig. 4 D) the frontal arms of the cleavage line go dorsal to the paired ocelli, and, in the adult insect, appear to be confluent with the temporal sulci (*ts*) that turn back from them over the top of the head. As already explained, however, this apparent continuity of the cleavage lines with the temporal sulci is due to the invasion of the former, on the inner surface of the head wall (G), by spurs (*d*) from the temporal ridges (*TR*). On the head exuviae of a nymphal mantis (E, F) it is seen that the temporal sulci (*ts*) do not reach the arms of the cleavage line. At ecdysis of the mantid the frontal clefts extend to the compound eyes and cut deeply into the corneae (F, *E*) as in *Forficula* (C). The lower halves of the corneae are then pulled downward with the depression of the frontal apotome (F, *frapt*), and the mouth parts and antennae project posteriorly beneath the head capsule.

In the Phasmatidae, Blattidae, and Gryllidae, the arms of the cleavage line appear to end at the lateral ocelli. In a nymph of *Periplaneta americana* undergoing ecdysis (fig. 4 H), however, it is to be seen that the frontal splits go below the ocellar spots and proceed to the mesal angles of the antennal fossae, whence they turn upward along the dorsal rims of the fossae to points above the bases of the antennae. The parietal lobes of the head exuviae are then forced to each side by the emerging head of the new instar, producing deep folds through the corneae of the compound eyes, but not splitting them. Finally, the facial region of the slough is turned flat ventrally (I) as in the mantid, forming deep infoldings of the eyes and the genae on each side, the edges of which partially overlap the bases of the antennae. The exuviae of the maxillae and labium are drawn up into deep pockets on the under side of the head.

In *Grylloblatta,* Crampton (1932) shows the cleavage line on the head of a full-grown nymph with the arms going directly to the rims of the antennal fossae, and Walker (1931) indicates the same line very faintly marked on the head of an adult.

In nymphs of Acrididae the line of the exuvial cleavage is scarcely perceptible, but at ecdysis the thoracic split extends over the top of the head and forks at the upper end of the frontal costa. Duarte (1939) says of *Locusta migratoria* that the frontal splits of the

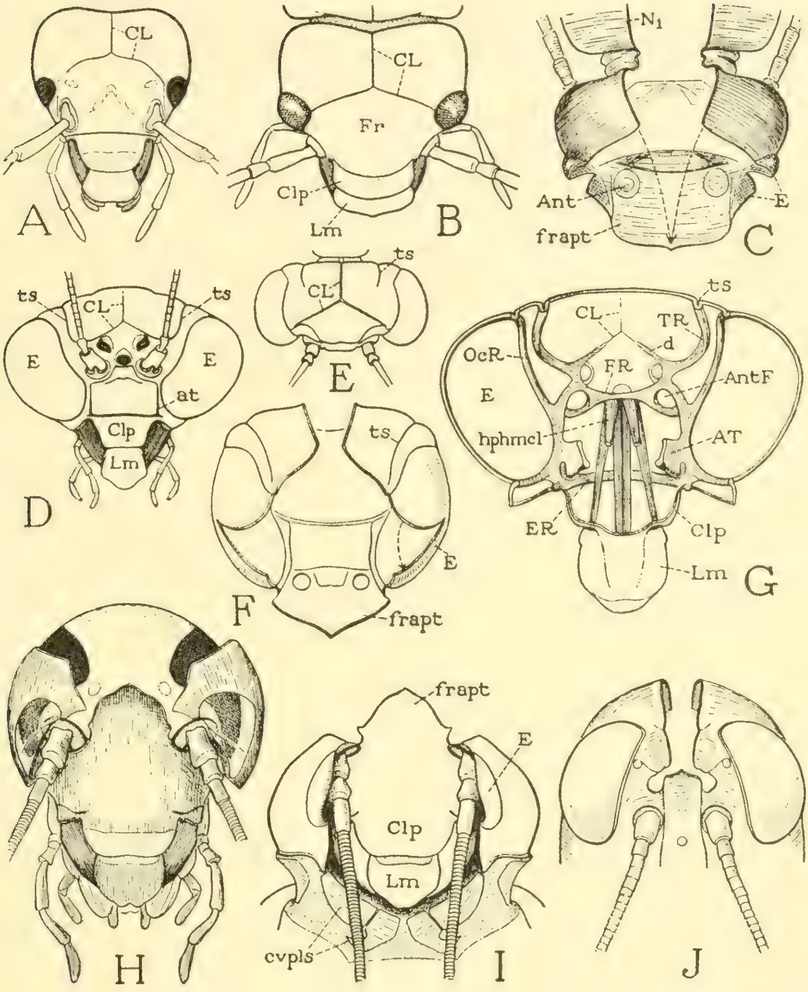

FIG. 4.—Dermaptera and Orthoptera.

A, *Anisolabis maritima* (Géné), Dermaptera, head of adult. B, *Forficula auricularia* L., Dermaptera, head of adult. C, same, exuviae of head and prothorax, frontal apotome turned downward. D, *Tenodera sinensis* Sauss., Mantidae, head of adult. E, same, head of first nymphal instar, dorsal, showing temporal sulci (*ts*) ending far from arms of cleavage line. F, same, head exuviae of last nymphal instar, frontal apotome turned downward. G, same, inner surface of facial wall of adult head, showing branch (*d*) of temporal ridge (*TR*) extending into arm of cleavage line (*CL*). H, *Periplaneta americana* (L.), Blattidae, head of adult emerging from nymphal cuticle. I, same, cast-off exuviae of head, ventral view. J, *Melanoplus differentialis* (Thos.), Acrididae, upper part of exuviae of head.

cleavage line reach the antennary sockets, but in *Dissosteira* and *Melanoplus* (fig. 4 J) the median cleft opens above the frontal costa in two short, wide lateral arms ending between the paired ocelli and the antennal sockets.

Hemiptera.—The line of cuticular cleavage on the head presents some interesting variations in this order. Though the frontal arms always go anterior to the eyes, and, when sufficiently extended, laterad of the antennae, the coronal stem is of variable length, and may be entirely absent. Many examples of the course of the "epicranial suture" in the Homoptera and the Heteroptera are given by Spooner (1938) in his comparative study of the head capsule of the Hemiptera. The nymphs of such species as *Ceresa* sp. (Membracidae), *Lyperonia quadrangularis* (Cercopidae), *Ranatra americana* and *Nepa apiculata* (Nepidae), *Gerris marginatus* (Gerridae), *Lampracanthus* sp. (Saldidae), *Alydus* sp. (Coreidae), and others are shown to have a typical Y-line of exuvial cleavage. In some others, however, the coronal stem is short and the frontal arms branch from it far back on the head, as illustrated by Spooner in *Cimex lectularius* (Cimicidae) and *Ischnodemus falicus* (Lygaeidae), and as shown in the present paper in *Oncopeltus fasciatus* (Lygaeidae) (fig. 6 A) and in *Cimex lectularius* (B). The ecdysial splits in *Cimex* follow the arms of the cleavage line and extend to the anterior dorsal angles of the eyes. The large frontoclypeal apotome of the exuviae (C, *frcapt*) is then turned forward and flat downward, with the beak directed posteriorly, while the narrow parietal lobes (*Prtl*) carrying the eyes and the antennae are spread out laterally.

Finally, in the Pentatomidae, as seen in *Brochymena* sp. figured by Spooner, and in *Acrosternum hilare* and *Mergantia histrionica* here illustrated (fig. 6 D, E), the coronal line is absent, and the frontal lines arise widely separated on the occipital margin of the cranium. At ecdysis of such species, the frontal splits, branching directly from the median cleft of the thorax and neck (fig. 6 D), cut off small, lateral parietal triangles of the vertex (*Prtl*) bearing the compound eyes, and leave the median part of the cranial margin unbroken.

The frontal arms of the cleavage line also are variable in length and position. They may reach to points between the eyes and the antennae (fig. 5 A; fig. 6 A), but more often they do not extend beyond the eyes (fig. 5 D, E, F; fig. 6 B, E). When the coronal stem is relatively long the arms may diverge forward on the top of the head, as in the nymphal cicada (fig. 5 A), in which at ecdysis the frontal splits cut out a small triangular frons (B). In the Fulgoroidea, however, which have a large frontal area on the anterior surface of the head (fig. 5 G, *Fr*), the arms of the cleavage line are either transverse (D, F), or they curve posteriorly to points before the eyes (E). In such species

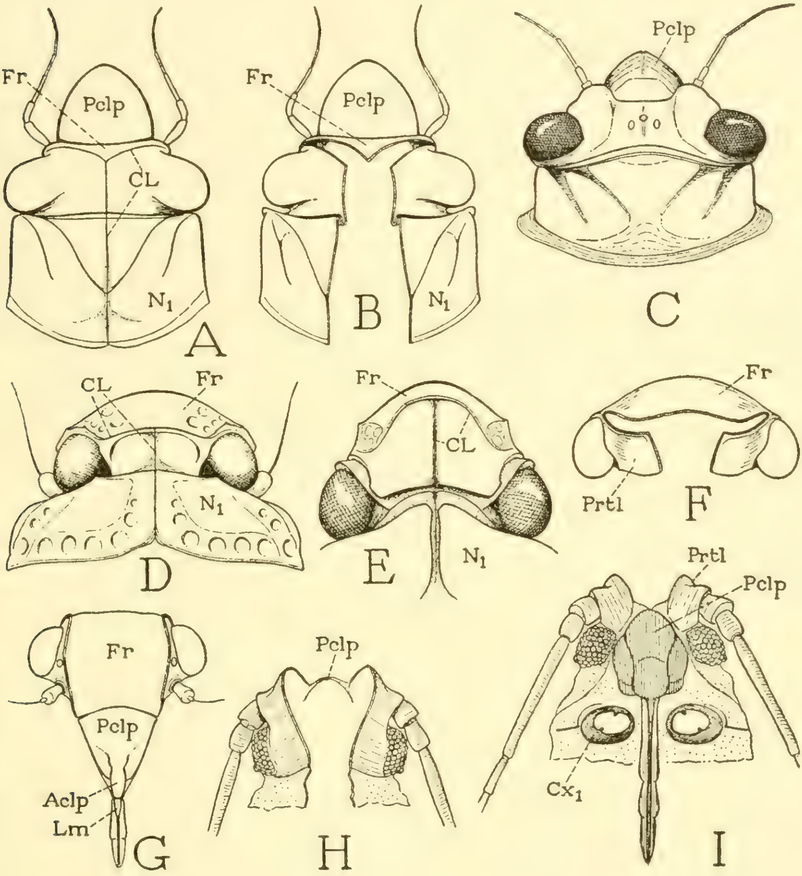

FIG. 5.—Homoptera.

A, *Magicicada septendecim* (L.), Cicadidae, head and pronotum of last nymph, dorsal view. B, same, exuviae of head and prothorax. C, same, head and pronotum of adult. D, *Catonia nava* (Say), Fulgoroidea, head and pronotum of nymph. E, *Epiptera florida* (Walk.), Fulgoroidea, head and pronotum of nymph. F, *Catonia nava* (Say), Fulgoroidea, dorsal part of exuviae of head. G, *Ormenis pruinosa* (Say), Fulgoroidea, facial view of head of adult. H, *Hyadaphis xylostei* (Schrank), Aphididae, exuviae of head, dorsal. I, same, exuviae of head and prothorax, ventral.

the vertex is cut at ecdysis into a pair of parietal plates bearing the compound eyes (F), or the eye lobes of the nymphal cuticula (B).

In the Homoptera, at least in the nymph, the frons and the postclypeus are usually separated by an epistomal sulcus and ridge (fig. 5 A, G); but in the Heteroptera, as noted by Spooner (1938), the frons and the postclypeus are always confluent. In the latter suborder, therefore, the respective areas of the frons and the clypeus can be determined only by an examination of the muscle attachments on their inner surfaces. The muscles of the sucking pump pertain always to the clypeus. Since the usual labral and hypopharyngeal muscles are absent in Hemiptera, only the pharyngeal muscles of the frons are present, and they are to be identified as such by their separation from the pump, or cibarial, muscles by the frontal ganglion and its brain connectives.

The variations in the point of forking of the cleavage line on the head of Hemiptera are clearly correlated with the posterior extent of the frontoclypeal muscles on the dorsal wall of the cranium, since the arms of the line always diverge from the coronal stem above or behind these muscles (fig. 1 C-G). In the lygaeid *Oncopeltus,* for example, the frontoclypeal muscles spread over a large part of the upper wall of the head (fig. 6 F, *dlcb, dlphy*), and consequently the frontal arms of the cleavage line branch far back on the head from a very short coronal line (A), leaving only a small area to the vertex. In the Pentatomidae, however, the cibarial muscles (G, *dlcb*) of the sucking pump are so large that they crowd the pharyngeal muscles (*dlphy*) to the extreme posterior edge of the cranium. In this family, therefore, the frontal arms of the cleavage line branch directly from the dorsal cleft of the thorax (D, E), leaving the median area of the cranium intact. The dorsal part of the vertex in such species is eliminated, and the frons is in contact with the neck membrane. On the other hand, in the Fulgoroidea the clypeal muscles and the clypeus itself are relatively small (fig. 5 G, *Pclp*), while the frons (*Fr*) is a large area on the front of the head, and the vertex forms the upper surface limited anteriorly by the arms of the cleavage line (D, E).

The Aphididae appear to be exceptions among the Hemiptera in their manner of splitting the head cuticle at ecdysis. According to Henriksen (1932) there is no forking of the cleavage line on the head in either the Aphididae or the Psyllidae. Exuviae of *Hyadaphis xylostei* and those of another species examined by the writer show only a median split of the head cuticle from the occipital margin to the postclypeus (fig. 5 H, I). Weber (1928) in his study of *Aphis fabae* Scop. concludes that the frons and the vertex are fused since there is no line of separation between them, but he says that in the wingless form there is a suggestion of a median line on the head. However, considering the small size of the frontal area between the arms of the cleavage line in the nymphal cicada (fig. 5 A, B, *Fr*), it might be supposed that in the aphids the frons has been entirely obliterated.

Finally, it may be noted that a method of ecdysis having no relation to that in other insects occurs in the Aleyrodidae and Coccidae. In

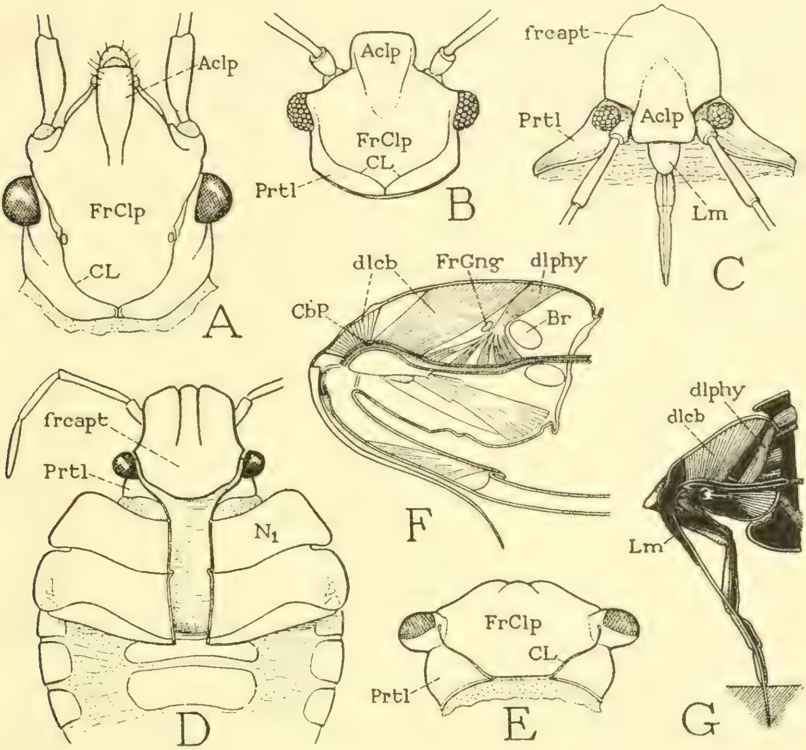

FIG. 6.—Heteroptera.

A, *Oncopeltus fasciatus* (Dallas), Lygaeidae, head of nymph. B, *Cimex lectularius* L., Cimicidae, head of nymph. C, same, exuviae of head, ventral. D, *Acrosternum hilare* (Say), Pentatomidae, exuviae, dorsal. E, *Mergantia histrionica* (Hahn), Pentatomidae, head of nymph. F, *Oncopeltus fasciatus* (Dallas), Lygaeidae, section of head (simplified from Butt, 1939), showing distribution of cibarial and precerebral pharyngeal muscles on frontoclypeal area of head. G, *Graphosoma italicum* (Müller), Pentatomidae, section of head (from Weber, 1930), showing cibarial and pharyngeal muscles occupying entire extent of dorsal wall of head.

Trialeurodes vaporarium (West.), as described by Weber (1931), at each of the first three larval ecdyses the cuticle is split around the anterior end of the body between the dorsal and ventral surfaces, and the emerging insect pushes the exuviae off the rear end of the abdomen. At the final ecdysis there is formed also an anterior marginal cleft, but the adult emerges from a T-shaped dorsal opening formed by a median split through the cephalothoracic region and a transverse cleft between the thorax and the abdomen (see Weber, 1931, figs. 20, 21).

Anoplura.—The exuvial cleavage line on the head of the sucking lice is typically Y-shaped (fig. 7 A, C, D), with some variation in the length of the coronal stem according to the length of the head. At ecdysis, the clefts along the frontal arms go mesad of the antennae and thus take a course characteristic of holometabolous larvae, but which has not been observed to occur in other ametabolous or hemimetabolous insects.

In *Pediculus humanus corporis* the cleavage line is not visible on the head of younger nymphs; in later instars and in the adult it is present but very faintly marked, and appears as illustrated by Stojanovich (1945) in the adult (fig. 7 C). In mature nymphs evidently just before emergence of the imago, however, the cleavage line is a pale, distinctly double-edged tract of the head cuticle (A), and it may now be observed that the frontal arms extend to the basal membranes of the antennae. At ecdysis the splits along the arms are farther extended mesad of the antennae to points (*x, x*) at the sides of the conical fore part of the head. The discarded exuviae have the frontal apotome (B, *frapt*) turned forward on the transverse axis between the ends of the frontal clefts (*x, x*), together with the snoutlike cone of the head, while the parietal parts of the cuticle are spread out laterally, and in a ventral view (B) are seen to carry the eyes and the antennae.

In the lengthened head of *Haematopinus suis,* as shown by Stojanovich (fig. 7 D), the coronal stem of the cleavage line is relatively long, but the arms go mesad of the antennae to points anterior to the antennal bases. The frontal lines of cleavage are therefore the same in both *Haematopinus* and *Pediculus,* though in the latter the full length of the clefts is not evident until the ecdysial splits are formed.

The distribution of muscle attachments on the frontoclypeal region of the anopluran head is shown by Stojanovich in several species, including *Pediculus humanus* (fig. 7 C) and *Haematopinus suis* (D). It is to be seen that these muscles include, as in other insects, the cibarial dilators (*dlcb*) and the muscles of the labrum, hypopharynx, and pharynx, and in addition the antennal muscles. In *Pediculus* (A, C) a weakly sclerotized band of the cuticle crosses the head between the antennal bases, and appears to separate approximately the clypeal region from the frontal region, but it is questionable if it represents the epistomal sulcus of other insects. As between *Pediculus*

(C) and *Haematopinus* (D) there is no essential difference except in the relative length of the head and the presence of the interantennal band of weak cuticle in the former. Yet Stojanovich calls the arms

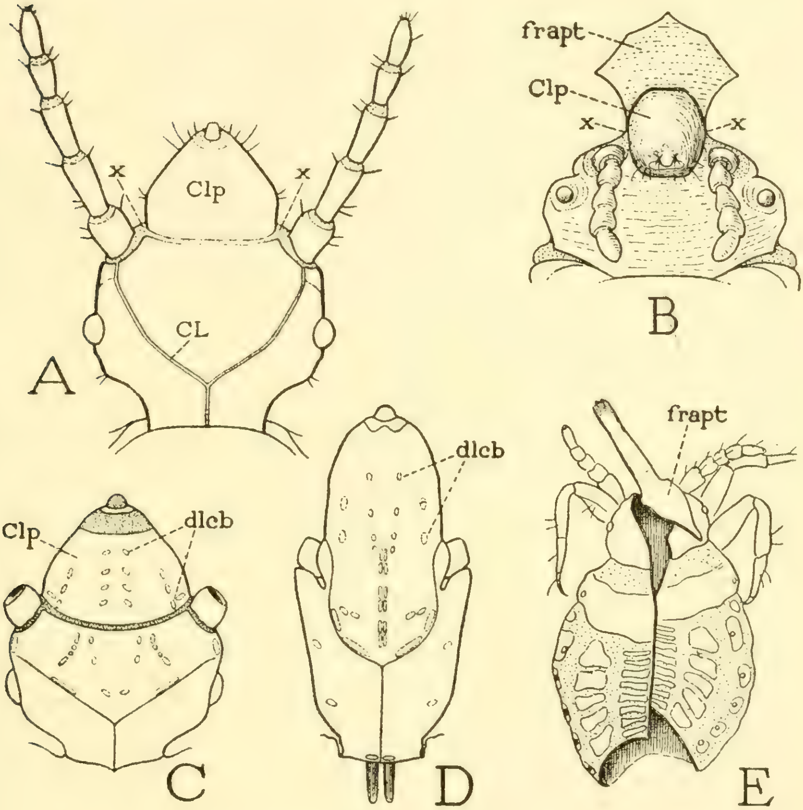

FIG. 7.—Anoplura and *Haematomyzus*.

A, *Pediculus humanus corporis* Deg., head of male nymph just before ecdysis. B, same, exuviae of head, ventral; frontal apotome turned downward between points *x*, *x*, parietal lobes with eyes and antennae spread laterally. C, same, head of adult (from Stojanovich, 1945), showing distribution of muscle attachments. D, *Haematopinus suis* (L.), head of adult (from Stojanovich, 1945), showing muscle attachments. E, *Haematomyzus elephantis* Piaget, exuviae of first nymphal instar (from Weber, 1939).

of the cleavage line in *Pediculus* "postfrontal sutures," and those of *Haematopinus* the "clypeofrontal suture." In the first, the facial area embraced by the arms is designated the "antennal segment," in the second the "clypeus." To reconcile the muscle attachments with this interpretation of the skeletal areas Stojanovich makes the statement that the clypeus of *Haematopinus,* in the course of its posterior extension on the head, "has taken over the muscle origins that normally are found on the antennal segment." Why such an unnecessary and confusing interpretation should be invoked is not clear to the writer; it is scarcely to be credited that these two genera of Anoplura should differ so radically in the head structure when they appear to differ only in unessential ways. However, it should be noted that Stojanovich, earlier in his paper, says his interpretation is according to the "dictum of Ferris."

On the head of a young elephant louse, *Haematomyzus elephantis* Piaget, Weber (1939, 1939a) has shown that there is present a typical Y-shaped cleavage line, the frontal arms of which extend forward mesad of the antennae as in Anoplura. At ecdysis (fig. 7 E) the cuticle splits along the arms and there is cut out a triangular frontal apotome (*frapt*) in continuity with the dorsal wall of the elongate snout.

Coleoptera.—The larvae of beetles are of particular interest in a study of the lines of ecdysis on the head, inasmuch as they exhibit a transition in the position of the frontal arms from that in which the latter are called "postfrontal sutures" to that in which they become "frontal sutures," or, according to Cook (1943), the "clypeofrontal suture." A review of the many figures of heads of coleopterous larvae given by Böving and Craighead (1931) will show that in the majority of species illustrated the frontal arms of the cleavage line go either laterad of the antennae, or directly to the antennal fossae, but that in a few cases, as seen in *Dermestes* and *Eurypepla,* they run distinctly mesad of the antennae. The last condition, judging from the illustrations of Hayes (1929), evidently prevails in the larvae of Scarabaeoidea, though in this group the frontal lines may go also either to the antennal fossae, or laterad of them.

A few examples of the three courses taken by the arms of the cleavage line in coleopterous larvae are shown in figure 8 of the present paper. On the heads of *Trichodesma gibbosa* (B), *Crioceris asparagi* (C), and *Leptinotarsa decimlineata* (G) the arms end laterad of (or posterior to) the antennae; in the larvae of *Dytiscus* (A), *Chalcophora* (F), and *Hydrophilus* (I) they go directly to the antennal fossae, in *Dynastes tityus* (D) and *Alaus oculatus* (E) they run mesad of the antennae. It is clear, then, that in the Coleoptera there can be no distinction between "postfrontal sutures" and "frontal sutures"; there is here only a variation in the course taken by the arms of the exuvial cleavage line on the head. On the facial region embraced by the frontal arms (fig. 8 A) are attached the muscles of the labrum, if these muscles are present, the precerebral dilators of the pharynx, the hypopharyngeal muscles (*hphmcl*), and the

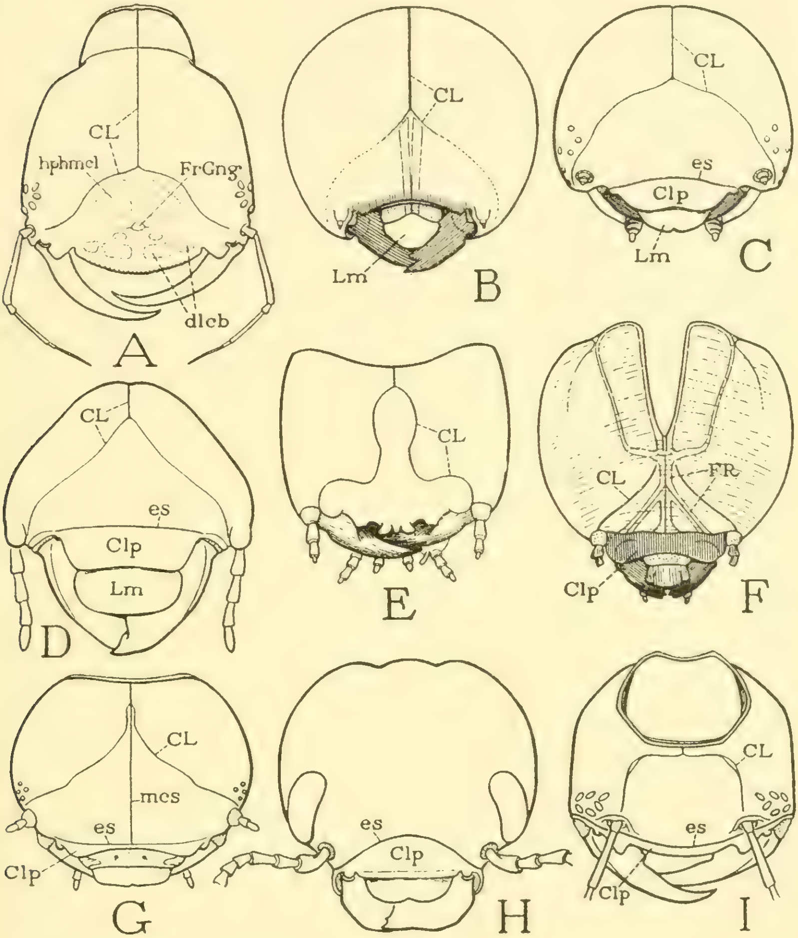

FIG. 8.—Coleoptera.

A, *Dytiscus* sp., Dytiscidae, head of larva, showing distribution of frontoclypeal muscles (see fig. 13 D). B, *Trichodesma gibbosa* (Say), Anobiidae, head of larva. C, *Crioceris asparagi* (L.), Crioceridae, head of larva. D, *Dynastes tityus* (L.), Scarabaeidae, head of larva. E, *Alaus oculatus* (L.), Elateridae, head of larva. F, *Chalcophora* sp., Buprestidae, head of larva. G, *Leptinotarsa decimlineata* Say, Chrysomelidae, head of larva. H, same, head of adult. I, *Hydrophilus* sp., Hydrophilidae, head of larva.

dilators of the cibarium (*dlcb*). The last are separated from the others by the frontal ganglion (*FrGng*) and its cerebral connectives. In some beetle larvae the frontoclypeal region is divided between frons and clypeus by an epistomal sulcus (C, D, G, I, *es*), in others it is not so divided (A, B, E).

The larvae of Buprestidae present on the inner surface of the dorsal wall of the cranium a system of strong, branching ridges (fig. 8 F). The vertex is deeply emarginate for the insertion of long muscles from the thorax, but from the apex of the cleft a thick, median, internal ridge (*FR*) runs forward to the strongly sclerotized clypeal plate (*Clp*) and gives off a pair of diagonal side branches to the lateral parts of the clypeus. From the proximal end of the median ridge two lateral ridges turn back to the occipital margin of the cranium and are continuous around the latter with the thickened edges of the cleft of the vertex. In a surface view of the head the grooves of inflection that form these cranial ridges are visible as fine lines through the middle of the ridges. On the larval head only the frontal arms of the cleavage line are present; they are pale, weak, double-edged linear tracts of the cuticle (*CL*) diverging from the apex of the notch in the vertex to the bases of the antennae. Between the upper ends of the arms arise the muscles of the labrum.

The structural contrast between grooves of cranial ridges and the lines of cuticular cleavage is so pronounced that there can be no mistaking one for the other. Yet, Cook (1943) would identify the arms of the frontal ridge in the buprestid larva with the cleavage lines of the *Corydalus* larva (fig. 10 A), for no other reason, apparently, than that in each case the lines go mesad of the antennae. The cleavage lines of the buprestid larva Cook terms "postfrontal sutures," and the V-line formed by the branches of the median frontal ridge he calls the "clypeofrontal suture." To say the least, such an interpretation results in a most confusing inconsistency and is in no way necessary. The fact appears to be simply that the frontal area between the cleavage lines of the buprestid larval head is reinforced by ridges to brace the otherwise weakly sclerotized cranium against the strong clypeal plate, which carries the mandibles; the cranium is thus enabled to withstand the pull of the huge mandibular muscles, the bases of which cover almost the entire parietal regions. If the frontal ridges were absent, there would be little to distinguish the head of a buprestid larva from the head of any other beetle larva. A median ridge extending from the occipital margin of the head to the clypeus is present also in larvae of Chrysomelidae (fig. 8 G, *mcs*), but in the adult (H) all the larval lines except the epistomal sulcus are absent.

The lines of cuticular cleavage in the larva are probably not retained in any adult beetle, though other lines of the adult head have frequently been mistaken for them, which is to say, they have been commonly termed the "epicranial suture." The water beetle, *Hydrophilus,* is sometimes cited as an example among the Coleoptera showing the presence of a complete "epicranial suture" in the adult insect (fig. 9 A); but an examination of the inner surface of the head (B) reveals the fact that the supposed "frontal sutures" form a thick internal ridge (*ER*) broadly united with a strong midcranial ridge (*mcR*) from the postocciput. The origin of the labral muscles (*lbrmcl*) above the transverse ridge demonstrates that the latter is the epistomal ridge (*ER*) and that its external sulcus (A, *es*) delimits the clypeus and not the frons. The true cleavage lines on the larval head of *Hydrophilus* (fig. 8 I, *CL*) are quite different things. Similarly in other beetles the epistomal sulcus has often been mistaken for the arms of the "epicranial suture," as in figures by Stickney (1923), with the consequence that the clypeus is wrongly identified as the "frons."

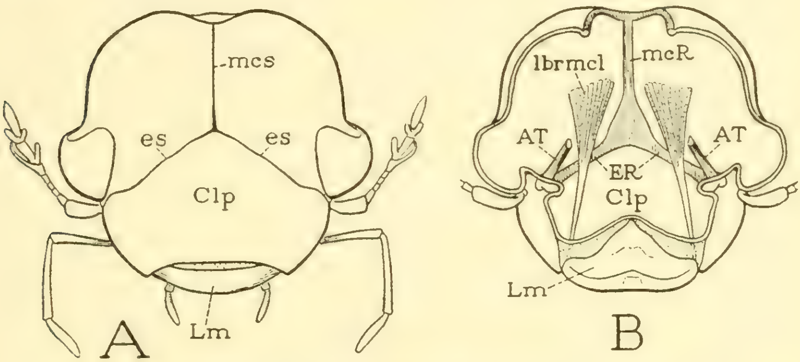

FIG. 9.—*Hydrophilus triangularis* Say, Hydrophilidae, head of adult.

A, facial view of head. B, inner surface of facial wall of head with labral muscles, showing a strong midcranial ridge (*mcR*) united with the epistomal ridge (*ER*), forming the supposed "epicranial suture" on the outer surface (A).

In most of the Coleoptera, both larval and adult, the cibarium is a preoral food pocket (fig. 13 A, *Cb*) as it is in *Orthoptera* and other more generalized insects (fig. 2 D). The hypopharynx, though always united with the labium (fig. 13 A, F), retains its frontal muscles (*hphmcls*). In the dytiscid larvae, however, the cibarium becomes a closed chamber by the interlocking of the labrum with the labium, and is drawn out between the mandibular bases into a long transverse tube, the hypopharyngeal floor of which, or sitophore, takes the form of a strongly sclerotized gutter. The cibarial dilator muscles (fig. 13 D, *dlcb*) are therefore distributed transversely on the distal part of the frontoclypeal area of the head (fig. 8 A) anterior to the frontal ganglion (*FrGng*). The large hypopharyngeal muscles (fig. 8 A; fig. 13 D, *hphmcl*), on the other hand, arise behind the frontal ganglion connectives; they are inserted on a pair of broad platelike lobes of the sitophore, representing the oral arms of the hypopharynx in other insects (fig. 2 D; fig. 13 A, F, *y*).

Neuroptera (*Megaloptera and Planipennia*).—The arms of the cleavage line on the head of neuropterous larvae go always mesad of the antennae in the manner characteristic of most Holometabola, and at their greatest extent they cut entirely through the clypeal area. On the adult head the cleavage line is absent.

The Megaloptera, including *Raphidia,* show very clearly the interantennal position of the frontal arms of the cleavage line (fig. 10 A, D, G). In the larva of *Sialis* (D) there is present a fully developed epistomal sulcus (*es*) setting off the clypeus from the frontal area behind it, and the arms of the cleavage line end at this groove. In *Corydalus* (A), *Chauliodes* (C), and *Raphidia* (G), however, the epistomal sulcus is represented only by short lateral grooves (A, *es′*, *es′*) containing the anterior tentorial pits (*at, at*), and in these forms the frontal arms of the cleavage line extend through the clypeal area to the distal margin of the latter. At ecdysis, as seen in *Chauliodes* (C), the frontal clefts cut out a triangular frontoclypeal apotome (*frcapt*). The frontoclypeal nature of the apotomal triangle is shown by the origin of the labral and hypopharyngeal muscles on its upper part (A, *lbrmcls, hphmcl*) and the attachment of the cibarial muscles (*dlcb*) on its lower part. In the larva of *Sialis,* in which the epistomal sulcus is complete (D), these same groups of muscles, as shown by Röber (1941), arise respectively on the frontal and clypeal areas of the prospective apotome.

The adult megalopteran head is like the larval head with respect to the development of the epistomal sulcus, the sulcus being complete in the imago of *Sialis* (fig. 10 E, F, *es*) as it is in the larva (D), but interrupted between the tentorial pits in *Corydalus* (B), *Chauliodes,* and *Raphidia* as it is in the larvae of these forms (A, C, G). The line of exuvial cleavage in the larval cuticle, however, is suppressed in the adults of all these latter genera (B). The adult head of *Sialis* presents a median groove that forks anteriorly into a pair of weakly impressed lines (E, F, *mcs*) diverging behind the antennal bases. Though these grooves of the imaginal head of *Sialis* are regarded by Röber (1941) as the "coronal suture" and the "frontal sutures," Röber notes that the latter do not have the position of the frontal lines of the larva, which he says are preformed lines for rupture of the cuticle at ecdysis.

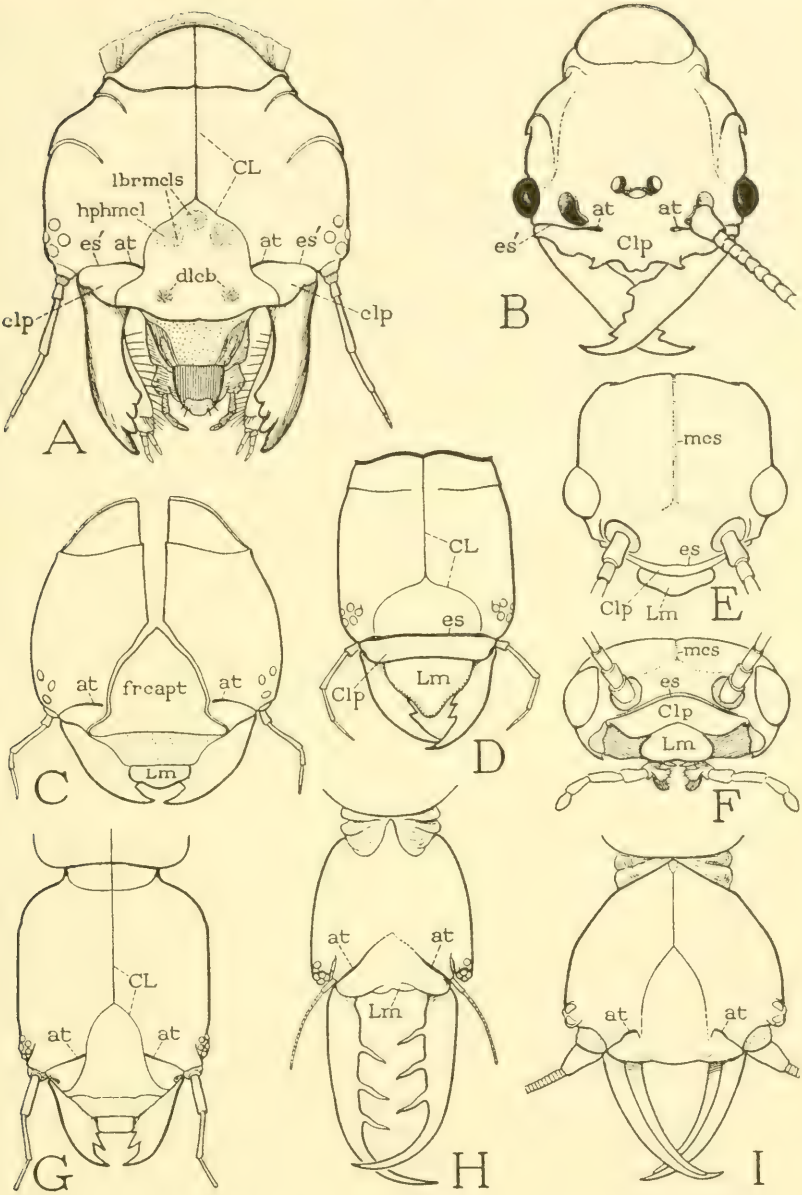

FIG. 10.—Neuroptera.

A, *Corydalus cornutus* (L.), Sialidae, head of larva, showing distribution of frontoclypeal muscles. B, same, head of adult female. C, *Chauliodes* sp., Sialidae, exuviae of head. D, *Sialis* sp., Sialidae, head of larva. E, *Sialis infumata* Newm., Sialidae, head of adult. F, same, anterior view of adult head. G, *Raphidia* sp., Raphidiidae, head of larva. H, *Myrmeleon* sp., Myrmeleonidae, head of larva. I, *Hemerobius* sp., Hemerobiidae, head of larva.

The Y-line on the adult head of *Sialis,* in fact, is merely a shallow groove of the sclerotic cranial wall, and would appear to have no direct relation to the exuvial cleavage line of the larva. Probably of the same nature is a similar head line in certain other adult Neuroptera, as that regarded by Ferris (1940) as the persisting "epicranial suture" in *Plega signata* (Hagen). A dried specimen of *Climaciella brunnea* (Say) shows a faintly impressed line on the head as in *Plega signata,* but on boiling in water the line completely disappears.

Among the Planipennia the hemerobiid larva (fig. 10 I) resembles the larvae of *Corydalus, Chauliodes,* and *Raphidia* in that the epistomal sulcus is incomplete and a Y-shaped line of ecdysis is present with the arms going mesad of the anterior tentorial pits (*at, at*), though they do not extend through the clypeal region. During ecdysis of hemerobiid larvae, Killington (1936) says, "the thorax becomes distended, and a split occurs dorsally along the thorax and extends along the epicranial and frontal sutures of the head."

In some of the other Planipennia, as *Chrysopa, Myrmeleon,* and *Ascalaphus,* the larval head shows no trace of the coronal line (fig. 10 H). Distally on the upper surface of the head, however, is a triangular area set off by the arms of a V-shaped groove containing the anterior tentorial pits (H, *at, at*). Sundermeier (1940) calls this area the "labrum," but he gives no attention to muscle attachments. In the *Myrmeleon* larva the cibarial muscles arise anteriorly on the triangle, which fact, together with the articulation of the mandibles on its lateral lobes, leaves no doubt that this area beyond the V-shaped groove is in part the clypeus. Owing to the immobility of the labrum, and the absence of a free hypopharynx, there appear to be no labral or hypopharyngeal muscles to identify the upper part of the triangle as the frons, but it should be noted that the head region above it is entirely occupied by the mandibular and maxillary muscles. The area in question, therefore, must represent the frontoclypeal region of *Hemerobius* (I) and of the Megaloptera, together with the labrum, the frontal area being reduced because of the absence of the usual frontal muscles.

There is little evidence available as to the manner of ecdysis in those Planipennia whose larvae have no apparent coronal line of exuvial cleavage on the head. Smith (1922) says of the Chrysopidae that at ecdysis the dorsal split of the thorax extends forward to the head. Henriksen (1932), in reference to Smith's observation, notes that if the cleavage line stops at the head, "this agrees with the fact that a Y-shaped suture cannot be discovered on the head of a *Chrysopa*-larva."

Mecoptera.—The line of the exuvial cleft on the larval head of Mecoptera (fig. 11 A, B, C) is identical with that of the Megaloptera in that the frontal arms go between the anterior tentorial pits and extend through the clypeus to points just mesad of the anterior mandibular articulations. The same structure is shown by Steiner (1930) and by Bierbrodt (1942) in the larval head of *Panorpa communis* L. (fig. 11 C), and by Applegarth (1939) and Cook (1944) in that of *Apterobittacus apterus* (MacL.) (B).

The area embraced by the arms of the cleavage line on the larval head of *Panorpa communis* is shown by Steiner and by Bierbrodt to be itself divided into three parts by a Y-shaped groove (fig. 11 C, *FR*), the stem of which is continuous with that of the line of cleavage (*CL*). Bierbrodt contends that the arms of this inner Y are the true "frontal sutures," while those of the outer Y (*CL*) are secondary lines of splitting at ecdysis. The latter, however, clearly are to be identified with the frontal lines of cleavage in other insects, which are commonly called the "frontal sutures." The lines of the inner Y, therefore, are more reasonably interpreted by Steiner (1930) as secondary grooves forming internal ridges correlated with muscle attachments; the labral muscles take their origins in the angle between the arms. In the larva shown at A of figure 11 the frontal area between the arms of the cleavage line is marked only by a shallow pigmented groove in the form of an inverted V, and apparently something similar is present in *Apterobittacus* as illustrated by Applegarth (1939); in *Harpobittacus* and *Boreus* the frons shows no corresponding structure.

The frontal and the clypeal areas of the mecopteron larvae are separated by a broad depression or a groove (fig. 11 A, B, C). The labral and the cibarial muscles are shown both by Bierbrodt (1942) and by Cook (1944) to arise respectively on the areas above and below this groove (B), but Cook regards the entire region between the arms of the cleavage line as the "clypeus," an interpretation entirely inconsistent with his own showing of the muscle attachments.

The line of exuvial cleavage so conspicuous on the larval head is greatly reduced or obliterated in the adult mecopteron. No trace of it is shown by Ferris and Rees (1939) in *Panorpa nuptialis* Gerst., by Evans (1942) in *Nannochorista maculipennis* Tillyard, or by Crampton (1932) in *Merope*. In *Panorpa communis* L., Heddergott (1938) describes and figures a small V-shaped groove over the median ocellus, which he regards as a remnant of the "frontal sutures," and Issiki (1933) shows a similar line in *Panorpodes paradoxa* MacL.), though he says there is a suppression of the "frontal sutures" in the Panorpidae. On the pupal head of *Panorpa communis* Bierbrodt (1942) shows the presence both of "frontal sutures" and a distinct "coronal suture." Otanes (1922) discusses

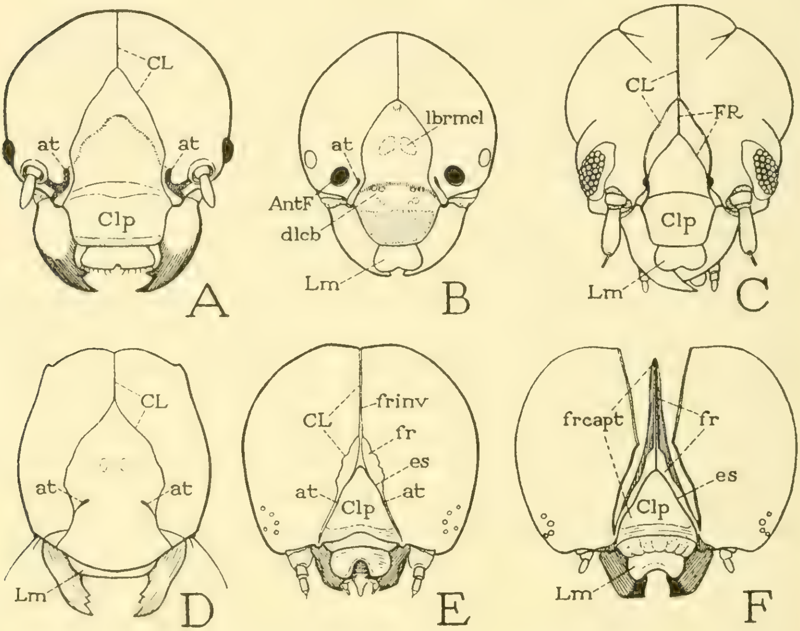

FIG. 11.—Mecoptera, Trichoptera, and Lepidoptera.

A, head of a panorpid larva. B, *Apterobittacus apterus* (MacL.), Mecoptera, head of larva (from Cook, 1944), showing distribution of frontoclypeal muscles. C, *Panorpa communis* L., Mecoptera, head of larva (from Bierbrodt, 1942), showing lines of Y-shaped frontal ridge (*FR*) between frontal arms of cleavage line (*CL*). D, head of a trichopterous larva. E, *Malacosoma americana* (F.), Lepidoptera, head of larva. F, *Hemerocampa leucostigma* (A. & S.), Lepidoptera, exuviae of head at last ecdysis.

"arms of the epicranial suture" in adult Mecoptera, but evidently he has reference to the epistomal and subgenal sulci.

Trichoptera.—The head of a trichopterous larva (fig. 11 D) is very similar in its facial structure to that of the larvae of Mecoptera (A, B, C) and of such Megaloptera as *Corydalus, Chauliodes,* and *Raphidia* (fig. 10 A, C, G) in that the arms of the cleavage line extend to the margin of the clypeus mesad of the mandibular articulations. It furthermore resembles the head of the megalopterous forms just mentioned in the absence of a separating groove between the frontal and clypeal areas embraced by the cleavage lines. In two species examined by the writer, however, the anterior tentorial pits lie mesad of the arms of the cleavage line (fig. 11 D), though in a species figured by Cook (1944) the pits are seen to lie in mesal angulations of the arms. Inasmuch as it is shown by Cook that the labral muscles and the hypopharyngeal muscles (mouth-angle retractors) arise above the level of the tentorial pits, while the cibarial muscles are on the widened area below the pits, it is evident that the region of the apotome is frontoclypeal, though Cook regards the whole triangle as the "clypeus."

Lepidoptera.—The head of a caterpillar is characterized by an upward extension of the clypeus in the form of a triangle on the lower part of the face (fig. 11 E, *Clp*), and by a complete invagination (*frinv*) of the upper part of the frontal area embraced by the arms of the cleavage line (*CL*). Below the invaginated part of the frons, the arms of the cleavage line diverge and run down along the sides of the clypeus to the mandibular articulations, thus defining a V-shaped frontal area (*fr*) inverted over the apex of the clypeus. The two arms of the frontal V are commonly termed the "adfrontals" by students of lepidopterous larvae, who have long regarded the triangular plate of the face as the "frons." A new interpretation by DuPorte (1946) relegates the clypeus to the conjunctiva which attaches the labrum to the cranium, and defines the facial triangle as an "antefrons," the groove bounding the apex of the triangle above the anterior tentorial pits being regarded as a "transfrontal suture," and the parts below the pits as "frontoclypeal sutures."

The several conflicting opinions that have been held concerning the homologies of the external lines and enclosed areas of the caterpillar head well illustrate the diversity of interpretation that may arise from a study of external features alone. Plausible evidence may be deduced from superficial characters for at least three interpretations, but, for this very reason, none of them is convincing.

The true structure of the median facial parts of the caterpillar cranium is revealed at the final ecdysis. On the head exuviae (fig. 11 F) the frontal clefts follow the arms of the cleavage line (E, *CL*) from the top of the head to the base of the clypeal triangle. Between the separated lateral hemispheres of the cranium there is now exposed the long apotome (F, *frcapt*), which is seen to include the triangular clypeus (*Clp*) and both the exposed and the invaginated parts of the frontal component (*fr*). The same structure can be demonstrated by treating the intact head with caustic. The median groove of the caterpillar's cranium (E, *frinv*), therefore, is not the coronal stem of the cleavage line, nor is it a midcranial sulcus; its margins are the approximated frontal arms of the cleavage line along the sides of the narrow invaginated part of the frons (F, *fr*).

Further evidence that the triangular plate of the caterpillar's head is the clypeus is seen in the fact that upon it (fig. 13 B, *Clp*) are attached the facial muscles (*cbmcls*) that lie anterior to the frontal ganglion and its brain connectives (*FrGng*). These preganglionic muscles are the cibarial dilators, though the cibarium of the caterpillar (*Cb*) appears to be continuous with the stomodaeum, and in no known insect are the cibarial muscles attached elsewhere than on the clypeus. On the other hand, the postganglionic muscles (*phmcls*), or precerebral dilators of the pharyngeal region of the stomodaeum, take their origins on the narrow strips (*fr*) between the cleavage lines and the apex of the clypeal triangle, and these muscles in all insects are consistently frontal muscles. Finally the labral muscles, which also characteristically arise on the frons, take their origins in the caterpillar far back on the median invagination of the cranium above the clypeus. All these skeleto-muscular relations, therefore, demonstrate that the exuvial apotome of the caterpillar head represents the frontoclypeal region between the arms of the cleavage line in other holometabolous larvae.

A rupture of the head cuticle does not take place at each ecdysis with all caterpillars. Many species shed the head capsule entire except at the last ecdysis, when the cranial cuticle splits in the usual manner. The head exuviae of the younger instars may be detached, or remain connected with the body skin. According to Frost (1922), in the bud moth, *Tmetocera ocellana* Schiff., the head capsule comes off separately at each ecdysis, the cuticular rupture taking place between the head and the thorax. In the Hesperidae, Henriksen (1932) says, "no opening of the head capsule takes place; the head of the new instar is drawn back through the occipital foramen of the old head capsule and out through the rent in the thorax." Usually in such cases it is to be observed that the head of the new instar develops in the thorax of the old skin before ecdysis. Hess (1937) describes the moulting of *Hemerocampa leucostigma* (A. & S.), *Hyphantria cunea* (Drury), and *Malacosoma americana* (F.) in all of which apparently the head capsule is shed entire at each ecdysis except the last, which takes place in the cocoon.

Diptera.—For a study of the cleavage lines on the larval head of lower Diptera, the mosquito furnishes a good subject, since many species have been described and figured, and it is easy to observe the fact that the ecdysial splits follow the lines ordinarily called the coronal and frontal "sutures." A review of recent papers on the head of larval Diptera will show, moreover, that the structure is essentially the same in all dipterous families in which the larva has a free head capsule. Anthon (1943) has described and figured the larval head in representatives of the Rhyphiceridae, Ptychopteridae, Trichoceridae, and Psychodidae; Cook (1944b) gives a full description of the head structure and musculature in a species of *Chironomus;* Ross and Roberts, in their Mosquito Atlas (1943), illustrate the larval head structure in 33 species of *Anopheles,* besides a species each of *Aedes* and *Culex,* and Cook (1944a) describes species of *Theobaldia, Anopheles, Lutzia,* and *Armigeres,* giving both the structure and the musculature of the larval head and mouth parts.

In all the forms illustrated by the writers just mentioned, the head of the larva presents a prominent Y-line having usually a short coronal stem and widely divergent frontal arms that go mesad of the antennae and embrace most of a large facial area that continues downward without interruption to the base of the labrum (fig. 12 A-D, F). As shown here in *Aedes* (E) and *Anopheles* (G), the ecdysial splits in the head exuviae extend to points just mesad of the antennal bases. On the large shield-shaped facial area of the apotome thus separated from the parietal lobes are attached in the intact head, as shown by Cook (1944a), the muscles normal to the frons and the clypeus (D). There would hence appear to be no reason for regarding this area as other than that of the frontoclypeal region of the cranium. However, Anthon (1943) designates it the "frons," and Cook (1944a) calls it the "clypeus." The first assumes that a downward extension of the frons has crowded out the clypeus, or reduced it to a pair of lateral lobes at the base of the labrum, and presumably that the frons has taken over the clypeal muscles; the second assumes the opposite, namely, that the clypeus has invaded the region of the frons and has appropriated the frontal muscles. If either assumption is necessary, one would seem to be as good as the other, but neither is substantiated by evidence to show that a shifting or transposition of any part of the cranial surface has taken place. The muscle attachments maintain the same relative positions that they have in insects in which the frontal and clypeal areas are separated by an epistomal groove, or in other insects in which this groove is absent. Since an epistomal sulcus is not usually present in holometabolous larva, and is variable in its occurrence even in adult insects, and since we have no evidence in dipterous larvae of either the frons or the clypeus having invaded the territory of the other, there is no reason for regarding the facial region between the arms of the ecdysial line and

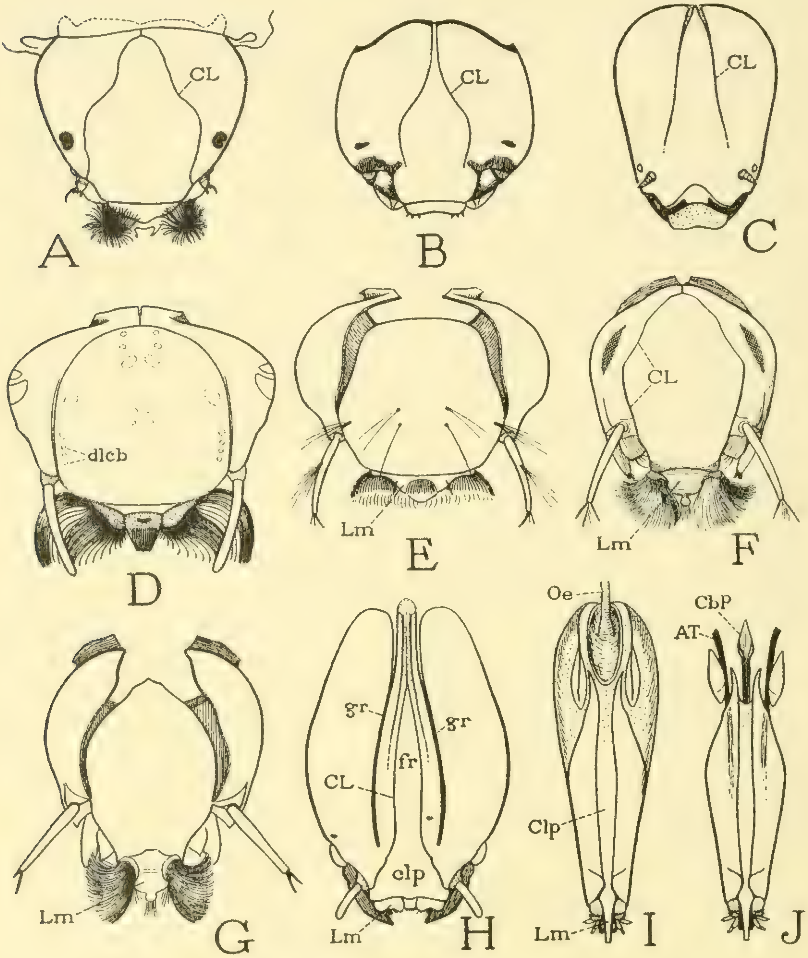

FIG. 12.—Diptera.

A, *Ptychoptera* sp., Liriopidae, head of larva (outline from Anthon, 1943). B, *Bibio albipennis* Say, Bibionidae, head of larva. C, *Lycoria* sp., Fungivoridae, head of larva. D, *Theobaldia incidens* (Thomson), Culicidae, head of larva (from Cook, 1944), showing distribution of frontoclypeal muscles. E, *Aedes increpitus* Dyar, Culicidae, exuviae of head. F, *Anopheles maculipennis freeborni* Aitken, Culicidae, head of larva. G, *Anopheles farauti* Lav., Culicidae, exuviae of head. H, *Tipula abdominalis* (Say), Tipulidae, head of larva. I, *Tabanus reinwardtii* Wied., Tabanidae, head of larva. J, same, exuviae of larval head.

the labrum as other than the unseparated areas of the frons and clypeus. If the cleavage lines were not present, it is doubtful if anyone would think of making any other interpretation. In adult Diptera the frontal and clypeal areas are usually distinctly separated, and the clypeus is identified as such by the attachments on it of the dilator muscles of the cibarial pump.

As already noted, Cook (1944a) has shown the distribution of muscle attachments on the frontoclypeal region in the head of the mosquito larva; the pharyngeal muscles are attached on the upper part (fig. 12 D), the cibarial muscles (*dlcb*) laterally on the lower part. In addition, however, are four groups of fibers, called by Cook the "messorial" muscles, which vibrate the labral mouth brushes, and which take their origin on the upper, presumably frontal, area of the frontoclypeal region. Cook concludes that these "messorial" muscles are probably specialized groups of cibarial fibers, but their functional connection with the labrum and their frontal origin would suggest that they are labral muscles, though admittedly it is difficult to identify them with muscles of the labrum in other insects.

The larva of Tipulidae may be taken as an example of the type of dipterous larvae in which the head is retracted into the thorax but still retains a relatively generalized structure. The dorsal surface of the ovoid head (fig. 12 H) presents two deep, longitudinal sclerotic grooves (*gr, gr*), between which the arms of the cleavage line (*CL*) demark a narrow frontal area (*fr*) continuous anteriorly with a wider clypeal area (*clp*) betwen their divergent distal parts, which end on the clypeal margin just beyond the bases of the antennae.

An examination of the head musculature of the tipulid larva shows a generalized arrangement of the cibarial and precerebral stomodaeal muscles (fig. 13 C), though the brain lies in the thorax. The cibarial muscles (*dlcb*) arise on the clypeal region (*Clp*), and the pharyngeal muscles of the stomodaeum (*phmcls*) take their origin on the frontal area (*fr*) between the cleavage lines. The two sets of muscles are separated by the frontal ganglion connectives, which turn back along the sides of the stomodaeum (*FrCon*) to the brain. On the frontal area are attached also the single, median pair of labral muscles (*lbrmcl*).

A quite different type of head structure is seen in the retracted head of a tabanid larva (fig. 12 I). Here the head is slender and club-shaped, thickened basally and tapering distally. On the dorsal surface two longitudinal lines separate a long, narrow median area (*Clp*), continuous distally with the labrum (*Lm*), from a pair of lateral plates of the head that end proximally in tapering points on the dorsal

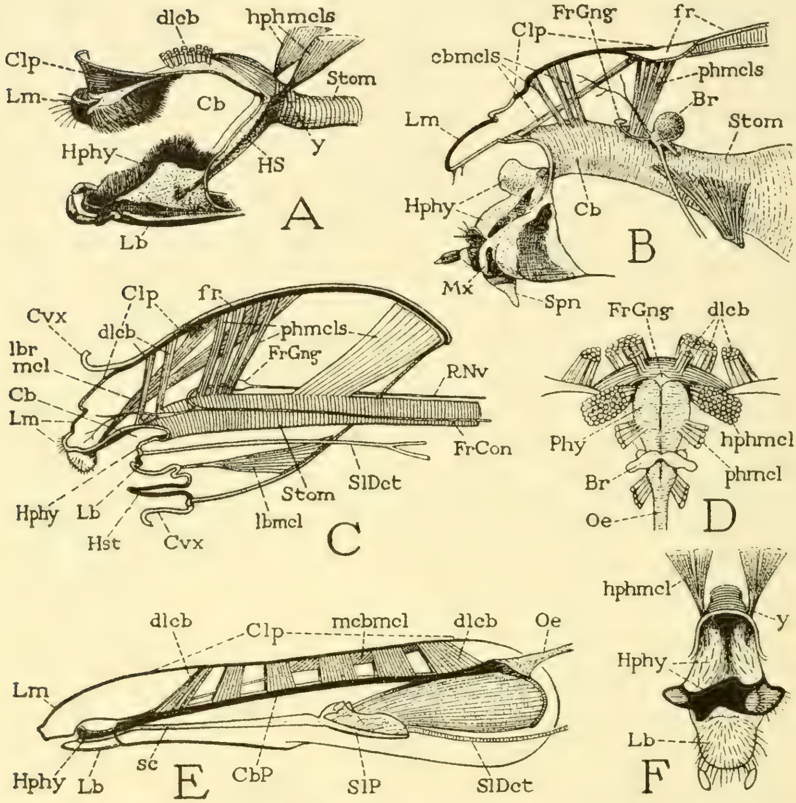

Fig. 13.—Examples of widely different head structures of various insects having the hypopharynx and labium united, showing the constant relation of the cibarial, hypopharyngeal, and stomodaeal muscles to the frontal ganglion connectives and to the clypeal and frontal areas of the head wall.

A, *Popillia japonica* Newm., Coleoptera, adult, lateral view of mouth region: cibarium (*Cb*) entirely preoral, frontal muscles of hypopharynx inserted on oral arms (*y*) of hypopharyngeal suspensoria (*HS*). B, *Malacosoma americana* (F.), Lepidoptera, larva, section of anterior part of head, showing cibarial and stomodaeal muscles; cibarium postoral, continuous with stomodaeum; brain in head. C, *Tipula abdominalis* (Say), Diptera, larva, sagittal section of invaginated head: cibarium preoral; brain in thorax. D, *Dytiscus* sp., Coleoptera, larva, dorsal view of cibarium and pharynx, with muscles: cibarium postoral, transversely elongate, its dilator muscles (*dlcb*) separated from hypopharyngeal and pharyngeal muscles by frontal ganglion connectives. E, *Tabanus reinwardtii* Wied., Diptera, larva, sagittal section of head: cibarium (*CbP*) a long sucking tube with its dilator muscles extending along entire dorsal surface of cranium; stomodaeum and brain in thorax. F, *Dynastes tityus* (L.), Coleoptera, larva, dorsal view of united hypopharynx and labium, showing frontal muscles of hypopharynx attached on oral arms penetrating the mouth angles.

surface. Laterad of the ends of these plates are two small elongate oval sclerites, but the rest of the basal part of the head is weakly sclerotized. When the head capsule is opened it is seen to contain three long, strongly sclerotic rods, two of which are lateral, and one median. The lateral rods arise at the base of the labrum and are attached posteriorly by their apodemal inflections to the posterior oval sclerites of the head surface. These rods evidently are tentorial arms. The median rod is the sclerotic floor of a tube extending the full length of the head (fig. 13 E, *CbP*), opening posteriorly into the oesophagus (*Oe*). This rod is clearly the floor (sitophore) of the greatly elongate, tubular cibarium; on the invaginated roof of the tube are inserted a series of paired muscles (*dlcb*) that arise on the median area of the dorsal head wall (fig. 12 I, *Clp*), which is thus seen to be the clypeus. In addition to the paired dilator muscles there is present also a median cibarial muscle (fig. 13 E, *mcbmcl*) inserted anteriorly by a long tendon. Confirmatory evidence that the sucking tube of the tabanid larva is the cibarium is seen in the fact that on a descending arm from the posterior end of its floor are attached the huge muscles of the unusually large salivary pump (*SlP*). The salivary pump muscles are always attached on the floor of the sucking pump in Diptera having a salivary pump, since these muscles primarily are hypopharyngeal and the floor of the pump is the sitophore of the hypopharynx in generalized insects.

At ecdysis the head of the tabanid larva shows none of the usual exuvial clefts. The soft posterior part of the head is torn off, while the sclerotic parts remain intact (fig. 12 J), with the tentorial arms (*AT*) and the sclerotic floor of the sucking pump (*CbP*) projecting from the posterior opening. It is to be noted that this exuvial remnant of the tabanid larval head is little more than the so-called "pharyngeal" skeleton of a cyclorrhaphous larva, which correctly is the combined clypeus and cibarial pump, represented in the adult fly by the composite structure commonly known as the "fulcrum."

Hymenoptera.—There is not much information available on the manner of ecdysis in Hymenoptera, but a few observations make it appear that the splitting of the head cuticle follows the usual lines in the Tenthredinoidea, and that in the higher Hymenoptera it is limited to a cleft down the middle of the face.

The head of a tenthredinid larva, as seen in *Neodiprion* (fig. 14 A), presents a prominent forked line of cleavage (*CL*), the widely divergent arms of which enclose a large quadrate facial region extending to the clypeal margin. The muscles attached on this region are shown by Parker (1934) in *Pseudoclavellaria amerinae* (L.), and by

Cook (1944) in *Zaraea americana* (Cress.), to include, on the upper part, the labral and pharyngeal muscles, and, on the lower part, the cibarial muscles. The two sets of muscles are separated as in other insects by the frontal ganglion and its brain connectives. The region in question, therefore, is frontoclypeal. The arms of the cleavage line, however, turn somewhat mesally at their distal ends and do not

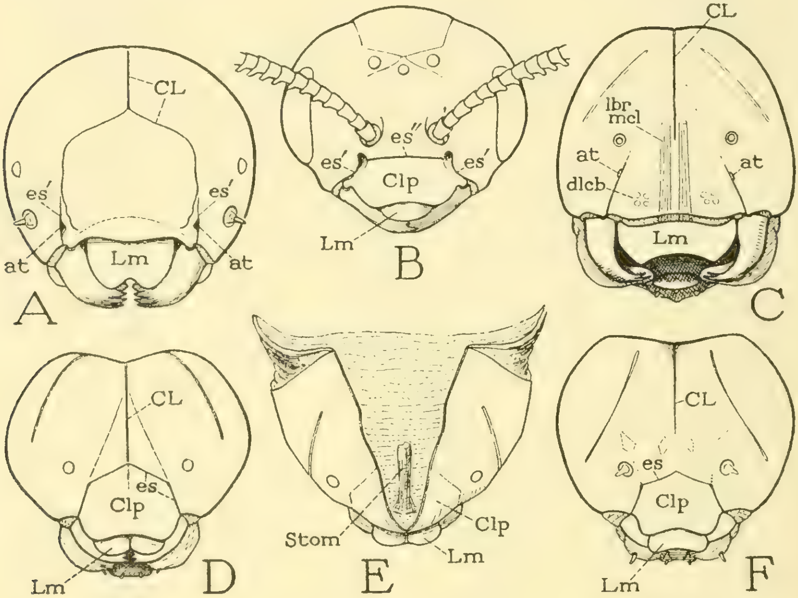

FIG. 14.—Hymenoptera.

A, *Neodiprion sertifer* (Geoff.), Diprionidae, head of larva. B, *Neodiprion dyari* Rohwer, Diprionidae, head of adult female. C, *Polistes* sp., Vespidae, head of larva. D, *Vespula* sp., Vespidae, head of larva. E, *Vespa crabro* L., Vespidae, head exuviae of last larval instar. F, *Xylocopa* sp., Apidae, head of larva.

extend entirely through the clypeal area. Just laterad of each mandibular condyle of the clypeus a short groove (*es'*) containing the anterior tentorial pit (*at*) extends upward close to the corresponding arm of the cleavage line, but does not blend with the latter. This groove and its mate on the other side evidently are larval representatives of the epistomal sulcus of the adult (B, *es*). At ecdysis the exuvial splits follow the frontal cleavage lines, so that the apotome does not carry the anterior tentorial arms.

The adult head of *Neodiprion* (fig. 14 B) differs in many respects from that of the larva (A). The larval line of ecdysis is entirely absent, the antennae have taken positions much nearer the middle of the face, the grooves containing the anterior tentorial pits converge toward the bases of the transposed antennae, and are now connected by a transverse groove (*es''*) between the pits, there being thus established in the adult a complete epistomal sulcus setting off the clypeus from the frons. A comparison with other insect larvae in which the arms of the cleavage line go mesad of the tentorial pits (fig. 10 A, C, G, I) will show that in such cases the epistomal sulcus is either absent or represented only by short lateral grooves containing the pits. On the other hand, when the cleavage lines do not reach the level of the tentorial pits, a complete epistomal sulcus may be present in the larva (fig. 10 D). Also the sulcus may extend between the tentorial pits when the exuvial cleft does not follow the arms of the obsolete cleavage line, as seen in *Vespula* (fig. 14 D) and *Xylocopa* (F).

The head transformation of *Neodiprion* from larva (fig. 14 A) to adult (B) shows clearly that the epistomal sulcus of the latter has no relation to the cleavage line of the larva. The interpretation given by Cook (1944) in reference to *Zaraea americana* that in the larva the cleavage line of the head is the "clypeofrontal suture" seems, therefore, quite inconsistent with the facts. The groove appearing in the adult of *Neodiprion* that connects the anterior tentorial pits runs between the two sets of facial muscles that are separated by the frontal ganglion, and this groove, therefore, is the epistomal sulcus, or clypeofrontal "suture." The cleavage lines of the larva simply disappear with the transformation to the imago.

In the wasps and the bees the larval head shows no distinct arms of the cleavage line such as those of the Tenthredinoidea, but the coronal line is always present (fig. 14 C, D, F, *CL*). This fact would suggest that the exuvial split at ecdysis follows the coronal line alone. The only example of the head cleavage at ecdysis in the higher Hymenoptera here presented, however, is that of *Vespa crabo* (E), in which it is to be seen that the head exuviae are bisected by a median cleft from the occiput to the labrum. Faintly impressed lines present on the head of *Polistes* (C) and *Vespa* (D), converging upward from the tentorial pits, are possibly remnants of the unused arms of the cleavage line. The larval head of *Polistes* (C) resembles the tenthredinid larval head (A) in that there is no transverse sulcus connecting the tentorial pits. In the larvae of *Vespula* (D) and *Xylocopa* (F), however, this sulcus is present as in the adult of *Neodiprion* (B) and sets off the clypeus from the frons. The manner of ecdysis in the Hymenoptera needs further investigation.

Symphyla.—The symphylid head becomes of interest in connection with a study of the cranial "sutures" of insects, because the Symphyla have been much exploited as possible ancestors of the hexapods. Ferris (1942), in fact, claims to find the basic structure and even the segmentation of the insect head fully revealed in the adult head of *Scutigerella immaculata* (Newp.).

The dorsal surface of the head of *Scutigerella immaculata* (fig. 15 A) presents a prominent Y-shaped median line (*a*), and a pair of lateral lines (*b, b*) diverging from near the base of the stem of the median line. The Y-line is the external mark of a strong internal ridge, the divergent arms of which extend toward the antennae and unite with the thickened rims of the antennal fossae opposite the pivotal processes that support the antennae. This Y-shaped ridge of *Scutigerella* must serve to strengthen the otherwise thin wall of the head. The arms of the ridge are regarded by Ferris (1942, p. 29) as representing the "clypeofrontal suture" of insects. Of the external groove of the median stem, Ferris says, "it evidently is the suture, common to so many arthropods, which breaks at the time of ecdysis, and there is no reason to regard it as anything different from the 'coronal' suture of insects." A very good reason to the contrary, however, may be drawn from the description by Williams (1907) of ecdysis in *Scutigerella immaculata,* or the same as recounted by Henriksen (1932), from which it would appear that this symphylid sheds its cuticle at ecdysis in the manner of other myriapods, namely, in most cases, by a transverse rent behind the head. "The most common method," Williams says, "is to disarticulate the cast at the junction of head and first segment and to creep out forward." But the animal may escape from the moulted skin also "by tearing between the legs or just above the attachment of the legs on either side or by tearing the dorsal covering longitudinally or by disarticulating the cast somewhere on the dorsal side and extricating the body." The Y-shaped "suture" on the head of *Scutigerella,* therefore, Henriksen points out, "does not play any role in moulting." A similar Y-shaped ridge is present on the head of some diplopods (fig. 15 B), but the arms in this case go to the eyes instead of the antennae. Finally, it should be noted that a Y-line of exuvial cleavage on the head is a feature peculiar to insects, and is not "common to so many arthropods" as Ferris asserts.

The two lines that form the V on the head of *Scutigerella* (fig. 15 A, *b, b*) are of quite a different nature from the Y-line, being merely clear linear tracts of the cuticle devoid of the minute setae that thickly cover the rest of the head surface. They begin as apparent clefts in the margins of the cranial sclerotization above the postantennal membranes containing the organs of Tömösvary (A, C), and converge posteriorly to points close to the base of the median cranial ridge.

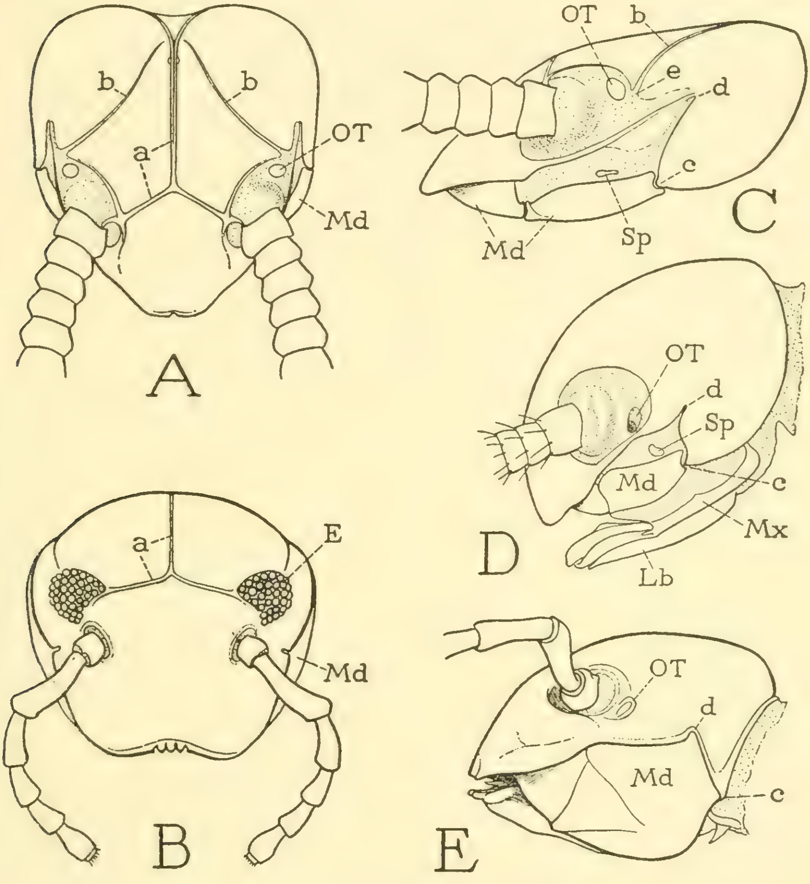

FIG. 15.—Symphyla and Diplopoda.

A, *Scutigerella immaculata* (Newp.), Symphyla, head of adult, dorsal. B, *Habrostrepus* sp., Diplopoda, head of adult. C, *Scutigerella immaculata* (Newp.), Symphyla, head of adult, lateral. D, *Hanseniella agilis* Tiegs, Symphyla, head of adult, lateral (outline from Tiegs, 1940). E, *Apheloria coriacea* (Koch), Diplopoda, head of adult, lateral.

In discussing these head lines of *Scutigerella,* Ferris (1942, p. 29) makes the following remarkable statement: "Another transverse suture begins at the side of the head, immediately in front of each primary mandibular articulation. For a short distance it coincides with the border of the cranium which takes the form of a small V-shaped notch. Thence the suture continues over the front of the head where it forms a large, inverted V posterior to the antennae." This description can best be followed by reference to a side view of the head (fig. 15 C). Beginning at the mandibular articulation (*c*) the alleged suture "coincides with the border of the cranium" to the point *d;* here it jumps the subantennal bar (which is the true lower lateral margin of the cranial wall, but is conveniently interrupted in Ferris' illustration, fig. 11 A), and then turns forward along the edge of the postantennal membrane to *e,* whence it runs mesally and posteriorly on the dorsal surface of the head as the line *b,* forming "a large, inverted V." To the writer it is quite incomprehensible how such diverse elements strung together can be even imagined to constitute a "suture." Yet, Ferris designates this variously composed line the "great suture of the head," and furthermore asserts that it is "evidently the suture between the mandibular and antennal segments." An examination of other species of Symphyla gives no evidence of the existence of any such suture, even the V-lines on the head being absent (D).

The symphylid head in its essential structure is identical with the head of a diplopod (cf. fig. 15 C and D with E). The lateral margin of the cranium below the postantennal membrane containing the organ of Tömösvary (*OT*) is a narrow bar in *Scutigerella* (C), forming a sharp angle (*d*) with the ascending margin above the mandibular articulation (*c*). The same structure is seen in *Hanseniella* (*D*), but here the subantennal bar of the cranium is wider; in the diplopod (E) the same part is a broad sclerotic area below the antenna and the organ of Tömösvary. The deep notch of the lateral cranial margin is characteristic of both Symphyla and Diplopoda, but while it is entirely occupied by the mandible in the diplopods (E, *Md*), in the symphylids (C, D) a membranous area containing the head spiracle (*Sp*) intervenes between the mandible and the edge of the cranium. The symphylid head, in fact, has no structural likeness to an insect's head; it is clearly a slightly modified diplopod head, or vice versa. The structure of the head, the presence of a large, independently musculated gnathal lobe on the mandible, and the anterior position of the genital openings link the Symphyla with the progoneate Diplopoda.

SUMMARY

1. The insect cranium is *not* composed of "plates" united by "sutures."

2. Most of the so-called sutures of the head are lines of cuticular

inflection forming internal ridges; the ridges are the important structural features, the external grooves, or sulci, are merely incidental to the production of ridges.

3. The postoccipital sulcus is probably a line of union between two segments, apparently the first and second maxillary segments, and lines of union between sclerotized areas may occur on the ventral side of the head, such as a median "gular suture."

4. The so-called "epicranial suture," with its coronal stem and frontal arms, is, in the immature insect, a preformed line of weakness in the head cuticle along which the cuticle will split at ecdysis. The cleavage line may be carried over into the adult, though usually it is more or less suppressed or entirely absent in the imago; other grooves of the adult cranium have frequently been mistaken for it, and designated the "epicranial suture." In some insects the exuvial cleavage line goes through the middle of the head without forking.

5. The common Y-shaped cleavage line of the head is variable in different insects both as to the length of the coronal stem and the extent and course of the frontal arms. The arms may take five different facial positions (fig. 1 C-G); at one extreme they go to the compound eyes, at the other they go mesad of the antennae to the distal margin of the clypeus. The coronal stem may be very short, and is sometimes absent, in which case the arms proceed separately from the occipital margin of the cranium.

6. The arms of the Y-shaped cleavage line, therefore, do not define any fixed part of the cranium, and in this sense they have no structural value, nor do their variations in position affect the fundamental structure of the head; the ecdysial clefts merely cut the head cuticle in different ways in different insects.

7. On the other hand, whatever may be the course of the arms of the cleavage line, the latter run always through the cranial areas that intervene between the attachments of the mandibular muscles and those of the facial muscles.

8. The facial muscles attached on the cranium between the arms of the cleavage line are consistently separated into an upper group, including the labral muscles, the precerebral pharyngeal muscles, and the dorsal muscles of the hypopharynx, and a lower group composed of the cibarial muscles. The two groups are always separated by the frontal ganglion and its brain connectives.

9. The frontal ganglion, being developed from the anterior or dorsal wall of the stomodaeum just within the mouth, and connected with the primarily postoral premandibular ganglia, must have been originally a preoral nerve center of the ventral nerve cord. The

cibarial muscles lying anterior to the ganglion are therefore primarily preoral, while the hypopharyngeal and pharyngeal muscles attached on the head wall behind it are postoral.

10. The facial area of the head on which the cibarial muscles take their origin is, in generalized insects, the outer wall of a preoral lobe of the head known as the clypeus, which supports the labrum, and carries on its basal angles the anterior articulations of the mandibles. The cibarial muscles are primarily compressors of the clypeus.

11. The facial area of the head above or behind the clypeus, on which the hypopharyngeal, pharyngeal, and labral muscles take their origin, is commonly termed the frons. In some insects the frontal area is separated from the clypeal area of the head wall by a transverse groove, the epistomal sulcus, but in others the frontal and clypeal areas are continuous. When they are not thus separated the respective areas are to be identified by the muscles attached on them, and the identity of the two sets of muscles is to be determined by the position of the frontal ganglion and its brain connectives.

12. The term "frons" cannot be given a precise anatomical meaning. If "the frons" is defined as the facial area above the clypeus embraced by the arms of the cleavage line, it will vary in extent according to the position of the arms, in some insects it would carry the antennae, in others it would not. The term "frons," therefore, is serviceable only when applied to the general facial area of the head above the clypeus or the clypeal area.

13. The clypeus, being the area of attachment of the cibarial muscles, varies in extent according to the size of these muscles; the size of the muscles depends on the development of the cibarium. The clypeus, therefore, is usually relatively large in liquid-feeding insects, in which the cibarium forms the principal sucking pump, and in these insects the clypeus is extended upward, or posteriorly, at the expense of the frons. When, in such cases, an epistomal sulcus is absent, the muscle attachments relative to the frontal ganglion still serve to identify the respective areas of the clypeus and the frons.

14. Just as the frons is usually cut into three sections by the arms of the cleavage line, so also the clypeus may be divided when the arms extend through the clypeal area. The facial apotome, or triangle of the head cuticle cut out at ecdysis, therefore, may be either the median part of the frons alone, or the median parts of the frons and clypeus, depending on the length of the ecdysial clefts.

ABBREVIATIONS USED ON THE FIGURES

Aclp, anteclypeus.
Ant, antenna.
AntF, antennal foramen of cranium.
AntNv, antennal nerve.
AT, anterior tentorial arm.
at, anterior tentorial pit.

Br, brain.

Cb, cibarium.
cbmcls, cibarial muscles (same as *dlcb*).
CbP, cibarial pump.
CL, cleavage line ("epicranial suture").
Clp, clypeus.
clp, median part of clypeus between arms of cleavage line.
cprclp, compressor muscles of clypeus (dilators of cibarium).
cprlm, compressor muscle of labrum.
cvpls, cervical plates.
Cvx, neck, cervix.
Cx_1, prothoracic coxa.

D, deutocerebrum.
dlcb, dilator muscles of cibarium, primarily compressors of clypeus.
dlphy, dilator muscles of pharynx.
dt, attachment point of dorsal arm of tentorium on cranium.

E, cornea of compound eye.
ER, epistomal ridge.
es, epistomal sulcus.
es', lateral parts of incomplete epistomal sulcus.
es", median part of epistomal sulcus.

fm, food meatus.
FR, frontal ridge.
Fr, frons.
fr, median part of frons between arms of cleavage line.
frapt, frontal apotome.
frcapt, frontoclypeal apotome.
FrClp, frontoclypeal region of head.
FrCon, brain connective of frontal ganglion.
FrGng, frontal ganglion.

GngI, first postoral ganglion of ventral nerve cord, becomes tritocerebral lobe of brain.
GngII, III, IV, second, third, and fourth ganglia of ventral nerve cord.
gr, groove of cranial wall.

hphmcl, frontal muscle of hypopharynx.
Hphy, hypopharynx.
HS, hypopharyngeal suspensorium.
Hst, hypostoma.

I-IV, postoral somites.

Lb, labium.
lbmcl, labial muscle.
lbrmcl, labral muscle.
lbrNv, labral nerve.
Lm, labrum.

mcbmcl, median cibarial muscle.
mcR, midcranial ridge.
mcs, midcranial sulcus.
Md, mandible.
mdmcl, mandibular muscle.
Mth, mouth.
Mx, maxilla.

N_1, pronotum.

OcR, ocular ridge.
Oe, oesophagus.
OpL, optic lobe of brain.
OT, organ of Tömösvary.

P, protocerebrum.
Pclp, postclypeus.
phmcls, pharyngeal muscles.
Phy, pharynx.
Prtl, parietal area of cranium.

rao, retractor muscle of mouth angle, frontal muscle of hypopharynx (*hphmcl*).
RNv, recurrent nerve.

sc, salivary canal, outlet tube of salivary pump.
Sit, sitophore, floor of cibarial pump.
SlDct, duct of salivary glands.
SlP, salivary pump.
SoeGng, suboesophageal ganglion.
Sp, spiracle.
Spn, spinneret.
Stom, stomodaeum.

T, tritocerebrum.
TR, temporal ridge.
ts, temporal sulcus.

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(With Six Plates)

The investigations of the National Geographic Society–Smithsonian Institution expeditions at La Venta, Tabasco, yielded a quantity of valuable data on an important Meso-American culture which has come to be called "Olmec." This designation, with its shadowy ethnic connotations, is perhaps not the happiest one that could have been selected, but still it is better than the term "La Venta" suggested for the culture at the conference on the Olmec problem at Tuxtla Gutiérrez in 1942, for the site name should more properly be restricted to the particular component or horizon of Olmec culture represented there.

By way of background, the excavations at La Venta were not random explorations, but rather were part of a definite program mapped out by Dr. M. W. Stirling for an attack on the problem of Meso-American culture growth from the peripheries of Maya territory. After the first season's work at Tres Zapotes, Stirling recognized that he was dealing with a culture, which, though it had Mayan linkages, was not simply a pallid marginal derivative, but had some distinctiveness of its own. Among the more impressive discoveries he made was that of a carved date that appeared to refer to Baktun 7. Stirling also was struck by the stylistic similarities between the monumental stone art—particularly the colossal heads—and the mysterious "baby-face" or "Olmec" figurines of jade and of clay which had not at that time been associated with an archeologically known horizon. He reoriented his plan of research to allow for a more intensive study of this new culture of southern Veracruz state. Excavations at Tres Zapotes were continued into a second season, and on the basis of stratigraphic materials I was subsequently able to outline a local ceramic column which substantiated Stirling's conclusions as to the probable contemporaneity of the early date which he had based on a study of the stone monuments in that it revealed an early monochrome horizon which showed sufficient specific typological resemblances—not just vague similarities—to wares from archaic Mayan levels at far-away Uaxactun to warrant assigning it an approximately contemporary dating. Following conformably on this early horizon were two succeeding ones, Middle, and Upper Tres Zapotes. In the course of reconnaissance in the region, Stirling visited La Venta, where he found numerous monuments stylistically akin to those of Tres Zapotes,[1] and he judged the site to be an important one.

The work at Cerro de las Mesas in 1941 proved to bear only indirectly on the Olmec question, for we soon realized that neither in ceramics nor in any other important respect was that site like Tres Zapotes. It proved to represent an intrusive Highland culture, genetically related throughout its history to that of the Mixteca-Puebla area. This meant that the western or northwestern boundary of Olmec territory must have been between Cerro de las Mesas and Tres Zapotes, though the two sites are less than 50 miles apart, airline. The following year Stirling sent me to La Venta to obtain stratigraphic samples of the ceramics and to test the ceremonial structures. In 1943 Stirling and Wedel carried out extensive excavations of the ceremonial complexes, and subsequently, the former extended his reconnaissances of the region to the point of being able to define with considerable exactness the geographical extent of Olmecan culture. Since I was otherwise occupied, the La Venta pottery complexes gathered dust in Washington, and only recently has it been possible to study them. The complete report on the work at La Venta may be delayed for a time, so it seems well to summarize the results of the ceramic study.

La Venta is situated on a small islandlike structure of solid ground surrounded by swamps, a short distance northeast of the junction of the Tonalá and Blasillo Rivers. It lies some little distance inland, but so low is the general terrain that the low Gulf tides flood and ebb in the rivers and sloughs around the island. The habitable area is relatively small, and certainly would not have supported the manpower that must have been utilized to handle the stone monuments and build the massive structures—it seems more probable that the site was a ceremonial center with a small permanent population of priests, or priest-rulers, and their personal servants and perhaps artisans, supported by tribute from neighboring villages located on similar elevated areas among the swamps, from which, as well, the laborers were recruited for major constructional endeavors. If this

[1] Stirling, M. W., Stone monuments of southern Mexico. Bur. Amer. Ethnol. Bull. 138, 1943.

surmise is true, it indicates considerable centralization of authority and an elaborate organization. A series of 40 test pits was dug to locate the areas of continuous occupation. Thick beds of culture-bearing deposit were found to be few and small, although in many places extensive thin caps of deposit occur. On the basis of the evidence supplied by the test pits, three stratitrenches were put down. One, stratitrench 2, ran into sterile soil a few inches down—a recheck of the nearby deep test pit showed that a little gully or pocket had been filled with refuse, but the areal extent of deep deposit was negligible. The other two trenches had respectably thick layers of sherd-bearing refuse, 4 and 5 feet each, and between them yielded a total of a little over 24,000 pottery fragments.

From the esthetic point of view, La Venta ceramics are disappointing. One would scarcely anticipate finding so drab a lot of wares among the remains of the makers of the great sculptured monuments and the carved jades. Of course, part of this drabness derives from the poor preservation of the sherds, heavily eroded and leached by soil acids; now and again a better-preserved fragment shows a lustrous surface that suggests that the general effect of the pottery may have been more pleasing. Similarly, rare but well-executed bits of modeled ornaments, and occasional examples of graceful vessel forms (pl. 2) demonstrate that the manufacture of artistic wares was not beyond the makers' capacity. It would seem that the people of La Venta had but slight interest in ceramics as a field for artistic expression, not enough to lead them to elaborate the painting of their vessels, or to carve or incise anything but the simplest of designs on them. Painted decoration is extremely infrequent in our samples, and incised ornament, though a little more common, most often consists of a few circumferential lines about the rim or lip of a pot. A number of decorative techniques were known: in addition to modeling and pre-firing incising, heavy pre-firing grooving, punctation, and rocker stamping (pl. 1, *c-e*) occur in the local ware, but were utilized so infrequently that they scarcely show in the percentage tables. The high priest who conceived a monumental theme and chalked the guide lines on a huge block of basalt, and the master artisan who translated the guides into delicately modeled planes, both would seem to have been indifferent as to the appearance of the everyday vessels from which they ate and drank. Even the pieces which must have served ceremonial ends, to judge by the fact that they were placed in the cists in the Ceremonial Enclosure, were of the same rudely made types as the pots in daily use in the occuption areas.

On the basis of thickness of deposit, a most inexact criterion but one which is probably safe enough in a rough and ready way, we may judge the La Venta occupation to have been of moderate length. The two stratitrenches appear on the basis of ware distributions and trends to have been not contemporary but successive: the deposits of stratitrench 1, with an average depth of about 4 feet, succeed those of stratitrench 3, which had a thickness of about 5 feet, with little if any overlap. Ceramically speaking, there is no major break between the two deposits, indicating that they represent a continuum. Nine feet of culture-bearing deposit, in a tropical zone where so much of the organic refuse is destroyed or washed away completely, is really a fair amount. Fortunately, we are not completely dependent on rough guesses as to deposition rates for a chronological placing of the materials, for typologically they may be related to those of other sites at which ceramic columns have been established, particularly the Tres Zapotes sequence.

This is not the place for a detailed account of La Venta wares, but their general characteristics may be summarized briefly. While painted decoration occurs in simple, not to say crude, patterns, in red or black on one or another of the common slips, it is so infrequent that we may call the pottery essentially monochrome. Several of the major wares are very like certain Tres Zapotes monochrome wares, heavy-walled, not too well fired, with abundant coarse aplastic (which appears to be stream sand with a high proportion of quartz particles), and with about the same range of slip colors within the "brown" and "black" groups. White and red over-all slips occur in small quantities. As at Tres Zapotes, there was in use a firing method which produced dishes and bowls with dark gray and black bodies and nearly white or grayish rims. However it was done, at La Venta it was not so standardized as at the former site, but was practiced with a variety of different pastes. Even more like Tres Zapotes, there occurs an important group of vessels made from a very finely divided paste with no visible aplastic, which fired in some cases from orange to buff in color, and in others, to black and gray.

This is the same kind of pottery which I designated the "Polychrome Group of Wares" in the description of Tres Zapotes ceramics, because they became the chief vehicle for the polychrome decoration of the Upper Tres Zapotes period. However, it cannot be demonstrated that they bore painted decoration throughout their history, and I now prefer to call them Fine Paste wares and differentiate between their monochrome and painted varieties. The history of development of the Fine Paste wares will be of considerable import when completely worked out—I believe them to be ancestral to the well-known Fine Orange which is such an important time marker through most of central and southern Mexico. At La Venta Fine Paste wares occur in small but gradually increasing amounts in the stratitrench 3 deposit, and achieve a high numerical frequency in stratitrench 1. One important La Venta ware, Coarse Buff, which occurs throughout the combined deposits, did not appear at Tres Zapotes, nor can I relate it to any other described ceramic type.

Vessel forms, expectably enough, show numerous points of comparison with dominant Tres Zapotes types. Flat-bottomed low bowls, or dishes, with flaring sides, and rims which run through a series of variants from a simple direct to flaring to everted, are common in all wares (pl. 2, *b*), and "composite silhouette" bowls, with walls that lean in from an angular break, then recurve strongly to a flaring rim, likewise occur though they are never abundant. With these latter, as at Tres Zapotes, is associated a double, elongate **S** design. Both necked and neckless jars occur, the latter being one of the most frequent of all forms. As for modifications, both solid lugs and loop handles occur, though never in particular abundance. Feet and legs are noteworthy by their absence. There is only one example of a foot in the La Venta collections, and it may be an imported piece. Annular bases, on the other hand, are fairly common (pl. 2, *g*). It will be recalled that at Tres Zapotes heavy annular bases occurred also, although in addition various types of feet and legs, mostly of tripod vessels, were found. The over-all La Venta ceramic pattern is, in short, close to that of Tres Zapotes, and specifically to that of the Middle period.

Clay figurines from La Venta belong in the archaistic tradition of handmade, usually solid, figures, with features indicated by incising or applique or both (pls. 3-6). No mold-made specimens were found. Typologically, nearly all the La Venta pieces fit into the pattern represented by Middle Tres Zapotes, in which the rigidly standardized forms of the Lower period were manipulated and modified into a series of variants, owing in part, perhaps, to certain alien influences, but also to processes of local development and elaboration. At La Venta, some of the self-same types occur as in Middle Tres Zapotes, along with some variant types, the ultimate kinship of which with Lower Tres Zapotes is clear.

For cross-dating purposes, the La Venta figurines are most significant: they point to a very definite time correlation with Middle Tres Zapotes. This, it should be emphasized, is the same dating that the general picture of the ceramics suggests. One factor only suggests a modification: the high frequency of Fine Paste sherds in stratitrench 1. At Tres Zapotes, these wares, often adorned with painted decorations, attain high frequencies only in the Upper period, at which time a series of alien elements such as mold-made figurines, Teotihuacan-type tripod bowls, "candeleros" and the like suddenly make their appearance on the scene. Since all these latter traits are unknown from La Venta, it seems most logical to assume that the zone of development of the Fine Paste ceramics must have been in or near the La Venta region, and that they, or at least the increased emphasis on them, diffused from there in a westerly direction, that is, to Tres Zapotes, affecting the latter site at the same time as a series of new influences, presumably from the Highland, made themselves felt. The absence of the whole series of Highland elements at La Venta may be attributed to a slight time lag in diffusion, or to local conservatism—perhaps to both. I suggest that chronologically the La Venta occupation likely overlapped the Upper Tres Zapotes period slightly, or to put it another way, that the Middle Tres Zapotes-La Venta period persisted a little longer at La Venta. This slight extension in time need not modify to any great degree the rough equation of this period with the Tzakol of the Petén.

The fact that the ceramic inventories of the Middle Tres Zapotes–La Venta horizon reveals respectably long lists of differences as well as numerous similarities seems to me to be significant. It indicates that the two centers represent well-rooted local manifestations which, though descended from a common ancestral pattern, and though influencing each other throughout their history, nonetheless were sufficiently well established to have developed local specialties to which they clung. I trust it will not be considered unfair to mention that field inspection of sherds from San Lorenzo Tenoxtitlan, between the first two sites, likewise suggests that local specialization had been at work, resulting in another series of related but variant ceramic elements. Had Olmec culture, as we know it, been the result of a rapid but short-lived diffusion, we should find far more uniformity in its component elements.

The foregoing La Venta–Tres Zapotes comparisons have linked the two and have suggested an ancient and firm establishment of Olmec culture in the zone in which these sites are situated. The next step, logically, is to define the areal extent of the culture. In point of fact, our two key sites lie near the boundaries of the civilization they represent. Attempts have been made to delimit the Olmec area on the basis of the distribution of finds of Olmec figurines, particularly those of jade, but objects so portable are less trustworthy markers of the culture than such things as stone monuments in the characteristic art style, ceramic complexes, and patterns of mound construction. On the basis of these last-named criteria, Olmec culture at its greatest continuous expanse never crossed the lower Papaloapan on the west nor ranged much beyond the Tonalá-Blasillo drainage to the east. Our excavations at Cerro de las Mesas demonstrated that, although a few unmistakably Olmec pieces occurred, particularly among the jade specimens, and certain features suggested a certain kinship with an ancient widespread ceramic pattern which likewise appears to underlie the Olmec pottery complexes, the bulk of Cerro de las Mesas culture—pottery figurines, jade-carving, and stelae—represent transplantations of Highland patterns. A glance at a topographic map of the region shows readily why there are more fundamental points of difference between the cultural inventories of Cerro de las Mesas and Tres Zapotes than between the latter site and La Venta which is more than twice as far away. The lower reaches of the Río San Juan, the Papaloapan, the string of lakes connected by the Río Limón and the Río Cacique, and the innumerable small streams and sloughs emptying into the lower Bay of Alvarado, form a hopelessly uninhabitable morass of swamps which prohibited a westward extension of Olmec culture. While some commerce may have been carried on through the tortuous network of channels that crisscross this no-man's land, intimate contact of the sort that leads to diffusion of entire complexes seems to have been made impossible by this geographic barrier.

Similarly, the swamps of Tabasco restricted any eastward spread. La Venta, on one of the islands near the borders of the swamps, is the easternmost of the major ceremonial centers of the Olmec. The site of San Miguel, a short distance up the Blasillo, was presumably an occupation center tributary to the ritual focus. The southern margin of Olmec territory is more difficult to define precisely but it seems to correspond with the edge of the coastal plain, never extending into the foothills flanking the rugged highlands. La Ceiba, on the Río de las Playas, has been determined by Stirling's investigations to represent an overflow of the Chiapas highland, or "Upper Grijalva" complex, down into the lowland. The only point at which an approximate boundary cannot be set as yet is along the pass across the Isthmus. Perhaps there were Olmec outposts, or even secondary centers, clear across to the Pacific side. The occurrence of reliefs carved in purest Olmec style as far south as San Isidro Piedra Parada in Guatemala suggests strongly that such may have been the case.[2]

[2] Thompson, J. Eric S., Stone sculptures from southeastern Quetzaltenango. Carnegie Inst., Notes on Middle American Archaeology and Ethnology, vol. 1, pp. 100-112, fig. a, pp. 104, 111, 1943.

Well up in the Highlands of central Mexico, in the state of Morelos, is the site of Chalcacingo, where a series of bas-reliefs on the cliff face present pronounced Olmec characteristics.[3] This, if it proves to be in all respects an Olmec site, is the only one yet known situated definitely in the Highland area. To account for a colony so far detached from its native territory would require far more information than we yet possess. However, the presence of such an outpost might well explain the source of the well-known "baby-face" figurines in the Valley of Mexico Middle Culture. Possibly the site, if it was Olmec, had to do with some trade route, such as those linking the southern Veracruz homeland with Oaxaca and Guerrero.[4]

To summarize: The heart of the Olmec region lay in the coastal lowlands along the Gulf, in the region flanking the Tuxtla Mountains. There were cultural connections, and possibly colonies, to the southward across the Isthmus of Tehuántepec, and there may have been a few scattered outposts in the Highlands to the west, but the culture definitely centered in the narrow strip between the Papaloapan and the Tonalá-Blasillo.

The Middle Tres Zapotes–La Venta horizon, in which the art of sculpture reached its zenith, was also the period signalized by marked cultural isolation. That is, the forces producing the artistic climax came wholly from within the culture, and were not the results of external stimuli. Earlier, on the Lower Tres Zapotes level, and possibly even during a hypothetical developmental period in which the unique art style began to take form, there seem to have been lines of influence, particularly to the eastward, along which flowed traits and patterns such as the ceramic styles linking Lower Tres Zapotes with early Petén levels. However, there is no proof that the ancient Olmec only received elements of culture without contributing. On the contrary, there is a strong possibility that a number of complexes, such as the Jaguar Monster cult, had their origin among the Olmec, and spread eastward to the Maya and westward to the early Zapotec.[5]

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[3] Cf. figure in lower right, p. 171, in Covarrubias, M., El Arte "Olmeca" o de La Venta. Cuadernos Americanos, Año V, Julio-Agosto, pp. 153-179, 1946.

[4] Olmec jades seem to be not uncommon in Guerrero, so that parts of that state have been considered by some writers Olmec territory. Although the region is not well known archeologically, there are, however, no indications that any other remains unmistakably Olmec in type occur there, and it seems more likely that the jades were carried there in trade—perhaps in exchange for unworked jade. Our data are at present too few to settle the question conclusively, of course.

[5] Stirling has outlined a possible line of development of "Jaguar Mask panels" in his paper "An Initial Series Date from Tres Zapotes, Veracruz, Mexico,"

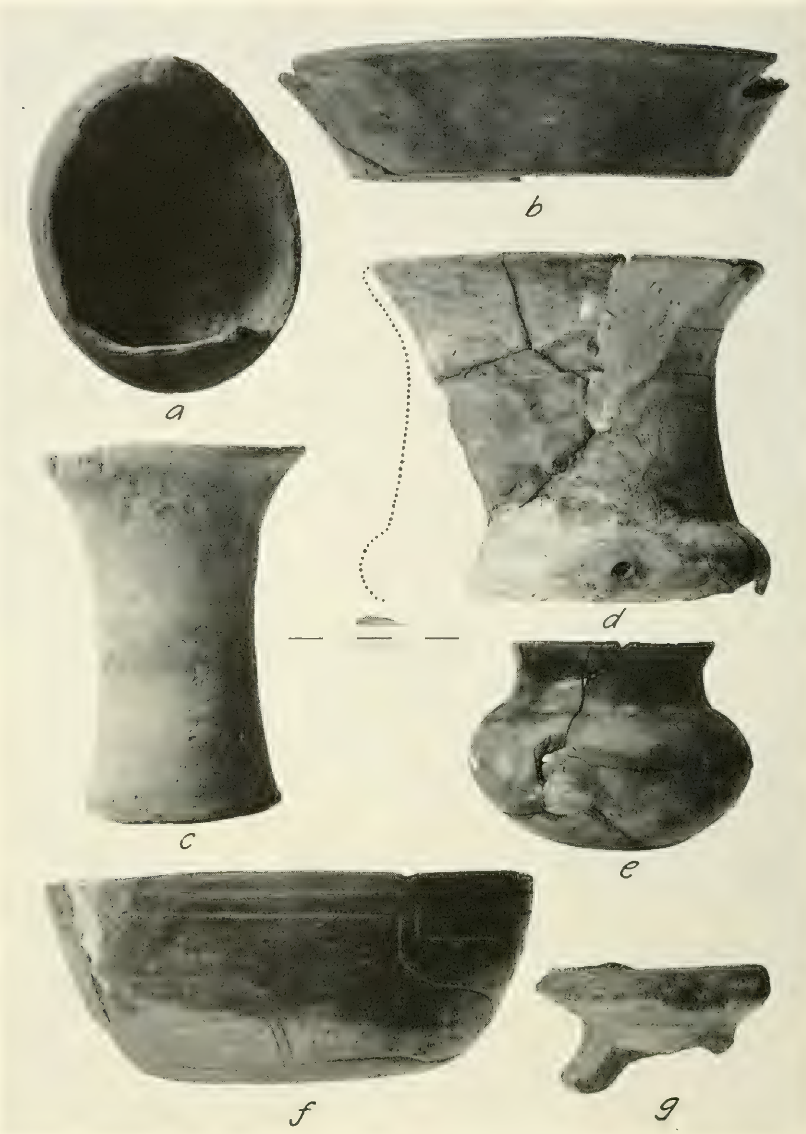
In other words, the Olmec area constituted a dynamic focus of culture from earliest times, until about A.D. 1000, when it mysteriously dwindled away.

The significance of this pictures lies in its flat contradiction of the classic appraisal of Meso-American civilization in terms of a single Mayan fountainhead of culture in which were evolved all the higher attainments of the area, and from which in diminishing intensity these complexes were diffused to backward neighbors whose rudeness was directly correlated with their remoteness from the "Mayan focus." The history of the Olmec indicates instead that the culture growth of the area is more likely to have been the result of interchanges between a number of local centers or foci, in each of which inventions, or elaborations of imported traits, were developed in accordance with local standards and then diffused or rediffused to neighboring provinces.

National Geographic series in Mexican Archeology, No. 1, 1940, which has been amplified and extended to include Monte Albán masks by Covarrubias in his recent contribution, "El Arte 'Olmeca' ó de La Venta," 1946.

VARIOUS LA VENTA CERAMIC PRODUCTS

a and *b* are unusual figurines: *a*, a startled small boy, *b*, a monkey skull apparently served up on a plate; *c*, *d*, and *e*, coarse buff sherds with rocker stamping and pre-firing incised lines; *f*, brown lacquer jar (approximately 35 cm. high).



VARIOUS LA VENTA VESSEL FORMS

a, an elliptical black ware dish; *b*, an example of a very common dish; *c*, the neck of a bottle-like vessel; *g*, an annular support of a small dish or bowl of coarse buff ware.

FIGURINES SHOWING CLOSE RELATIONSHIP TO MIDDLE TRES ZAPOTES MODIFICATIONS OF EARLY TYPES

LA VENTA FIGURINE TYPES SHOWING VARIATION OF EARLY PATTERNS

The derivation of these from Lower Tres Zapotes prototypes is apparent.

PROFILES OF FIGURINES SHOWN IN PLATE 4

Figurine Bodies from La Venta

Note the jaguar monster design on the belt of the specimen in the upper left.

SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 107, NUMBER 9

Roebling Fund

PRECIPITATION AFFECTED BY SOLAR VARIATION

BY
C. G. ABBOT
Research Associate, Smithsonian Institution

(Publication 3901)

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Research Associate, Smithsonian Institution

I published recently a paper entitled "The Sun's Short Regular Variation and Its Large Effect on Terrestrial Temperatures."[1] It showed a perfectly regular variation of the sun's output of radiation, with a period of 6.6456 days. Associated with this, but subject to occasional displacements of phase of 1, 2, or rarely 3 days, were temperature changes at Washington, St. Louis, and Helena, ranging from 2° to 20° Fahrenheit. I was unable to discover the causes of the displacements of phase and variations of amplitude in the terrestrial responses to the regular solar period, but averaged over many years the terrestrial effects showed the identical period found in the solar variation.

It occurred to me to test whether precipitation also responds to the 6.6456-day solar period. I did not expect much correlation, because precipitation in most regions is very irregular in amounts and intervals. However, a preliminary trial for Peoria, Ill., a station which previous studies showed to be largely dominated by solar variations, indicated that the 6.6456-day period is effective on precipitation there, but that phase changes similar to those noted above occur. I then undertook a statistical study of Washington precipitation, from 1924 to 1945, with reference to the 6.6456-day period.

As in the temperature studies, I made separate computations for each month of the year. It proved advisable to recognise the same phase shiftings that I had determined for temperatures. In order to see if the effect occurs at all times, I divided the data into three groups, 1924 to 1930, 1931 to 1937, and 1938 to 1945. All groups showed a considerable effect. To show the procedure, I now refer to figure 1, which is a facsimile of my computations for the middle group, 1931 to 1937, for March. I select a March group for illustration because table 3 of my paper (above cited) gives the phase shiftings for March in the temperature work, and I use in all months phase shift-

[1] Smithsonian Misc. Coll., vol. 107, No. 4, Apr. 4, 1947.

ings for the precipitation tables identical with those I used in collecting temperature effects.

Hence in figure 1 of the present paper the reader will find the date figures, which I have written small, not all in the column of zeroth day. They are found as follows: In the years 1931 and 1933 in column +2; in the years 1935 and 1936 in column +1; in the year 1937 in column −1; in the year 1932 in column −2; in the year 1934 in column −3. These shiftings are those idicated by tables 3 and 4 of my former paper. Without these phase shiftings the present results would be confused.

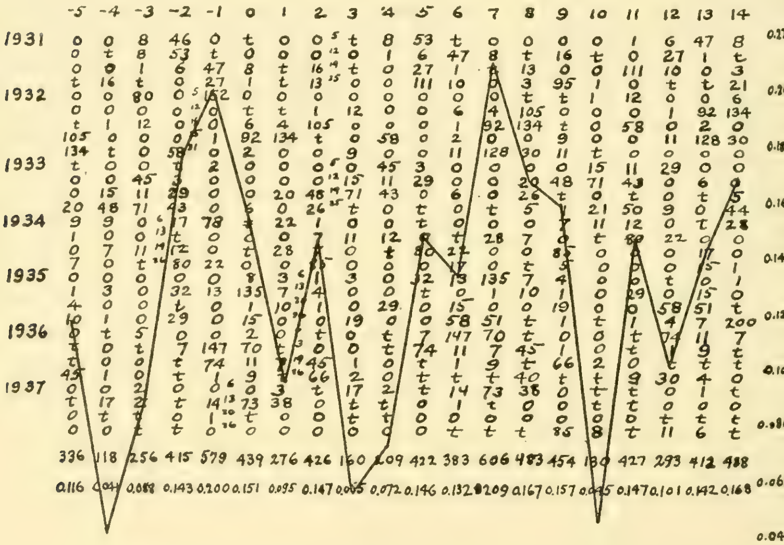

FIG. 1.—Computation of average effect, 1931 to 1937, of the 6.6456-day solar period on Washington precipitation for the month of March.

In figure 1 of the present paper, the top line indicates days from −5 to +14, with respect to zeroth day indicated basically in table 1 of my former paper. The next following 29 lines of figure 1 give for 20 days each the total precipitation, midnight to midnight, in hundredths of an inch, as published by the Weather Bureau for March 1931 to 1937. These data fix the form of the four or five returns of the 6.6456-day period which occurred in March of each year—thus in 1931 four, in 1932 five, et cetera. The next to last line of figure 1 gives the sums for each column, and the last line the average daily precipitation in inches for each of the 20 columns. At the right is a scale of inches, and in the body of the table a graph gives the results as written in the lowest line.

It will be noticed that the maxima are not exactly spaced at intervals of 6.6456 days, but they are approximately. The minima fall as closely to the correct intervals as could be, without dividing the days into hours. The range is from 0.040 to 0.204 inch, more than fivefold.

Having illustrated the procedure, I give in table 1 a summary of the places where the maxima were found in tabulations similar to figure 1, but covering, for each month of the year, all years from 1924 to 1945. This summary is entirely parallel to table 3 of my former paper. It was undertaken to correct for phase shiftings, before taking the general means of the effects. It seemed by no means to be assumed, without testing, that the lag of the effects of the solar change on precipitation would be identical for different seasons of the year. Table 1, however, gives little ground to conclude that there are different lags in different seasons. The phase shiftings determined in the present table 1 do not exceed ±1 day. These might easily have resulted from the facts (a) that no account is made of hours in the records; (b) that tabulations, similar to table 3 of my former paper, include frequent cases where a computed phase shifting might have been altered 1 day by a difference in judgment as to the position of centers of features of graphs. In order to get the best determination of the amplitudes of precipitation effects, I used the phase shiftings indicated in the present table 1, when collecting the results of the 12 months of the year.

TABLE 1.—*Phases of maxima in the 12 months, and phase corrections*

Days	Positions of maxima			Deviations from means			Average	Nearest integer
	I	II	III	I	II	III		
Jan.	1.5	4.5	11.5	+1.6	−1.5	−0.8	−0.2	0
Feb.	−1.0	6.0	12.5	−0.9	0.0	+0.2	−0.2	0
Mar. ...	−1.5	5.0	11.5	−1.4	−1.0	−0.8	−1.1	−1
Apr.	−0.5	6.0	13.0	−0.4	0.0	+0.7	+0.1	0
May ...	1.0	7.0	13.5	+1.1	+1.0	+1.2	+1.1	+1
June ...	1.0	7.0	13.0	+1.1	+1.0	+0.7	+0.9	+1
July ...	0.0	7.0	13.0	+0.1	+1.0	+0.7	+0.6	+1
Aug. ...	0.0	6.0	11.5	+0.1	0.0	−0.8	−0.2	0
Sept. ...	1.5	7.0	14.0	+1.6	+1.0	+1.7	+1.4	+1
Oct.	−1.0	6.0	12.0	−0.9	0.0	−0.3	−0.4	0
Nov. ...	−1.0	5.5	12.0	−0.9	−0.5	−0.3	−0.6	−1
Dec.	−1.0	5.0	10.0	−0.9	−1.0	−2.3	−1.4	−1
Sums ...	−1.0	72.0	147.5					
Means ..	−0.1	6.0	12.3					

I give in table 2 the collected results of the precipitation in the

12 months, these being averages taken over 22 years from 1924 to 1945. The results are shown graphically in figure 2. There is a slight departure from exact intervals of 6.6456 days between maxima, but the intervals between minima are as close to the correct interval as

TABLE 2.—*Precipitation at Washington in the solar period 6.6456 days. Phases adjusted. Mean values in inches per day, the 12 months, 1924-1945. Prefix 0.0 or 0.*

Days	—5	—4	—3	—2	—1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Jan.	812	873	1055	1628	1476	605	953	797	709	1246	1367	1031	735	821	525	877	1744	1546	484	1093
Feb.	947	801	509	1152	1245	895	1044	842	587	820	1133	1019	1115	792	980	777	898	1563	1534	1176
Mar.	....	1034	995	728	1312	1346	1012	870	1105	1158	1018	1178	1001	1205	1177	851	1336	1143	1068	1226
Apr.	939	1294	929	1972	1236	1059	920	903	1321	1036	1000	1663	1216	1052	638	862	972	1149	1378	784
May	777	999	1182	687	1188	1484	1075	623	1073	1164	830	1571	1199	711	966	1127	695	1025	1285	....
June	899	670	1541	941	1181	2128	822	1009	1048	1392	1555	1196	1570	787	944	1654	1624	1135	1610	....
July	1061	691	1235	1246	1735	1183	1122	634	856	1110	1427	1977	980	748	485	1347	1378	1224	1314	....
Aug.	2136	1256	1555	1509	1390	1857	1826	1615	1094	1899	1234	2489	1665	1610	928	1464	1944	1779	1090	1662
Sept.	2007	1147	1035	1324	1619	1090	1316	1654	1159	923	1354	2167	379	1272	1262	665	1118	1397	1586	....
Oct.	555	1210	555	1301	1475	1325	620	671	869	1045	901	1079	1103	860	991	513	1322	834	1069	1068
Nov.	....	507	1054	675	821	1991	730	380	773	696	1026	1631	1230	634	646	845	938	940	1040	1470
Dec.	....	901	558	797	752	1089	680	927	774	1014	846	1104	907	647	802	1019	1168	1033	657	514
Means	1126	949	1017	1163	1286	1338	1010	910	947	1125	1141	1593	1092	928	862	1000	1261	1230	1177	1114

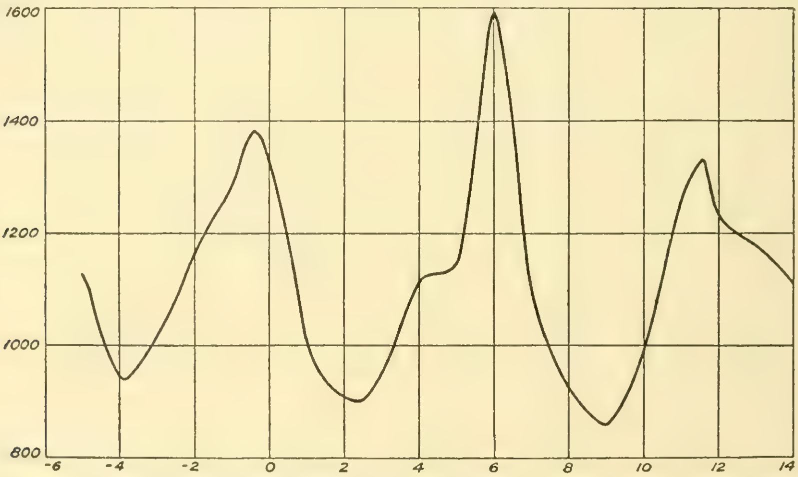

FIG. 2.—Graph of average effect, 1924 to 1945, all months, of the 6.6456-day solar period on Washington precipitation. Abscissae, days. Ordinates, inches/10,000.

can be shown without taking account of hours. The range of the effect is from 0.0862 to 0.1593 inch, a range of 85 percent.

It is indeed a pity that the shiftings of phase occurring with precipitation, as with temperature, are of unknown causation. If their causes could be found and the phase changes could be anticipated, here would be a valuable aid for forecasting. Perhaps it may have a valuable significance that the phase changes for precipitation are identical with those for temperature.

SMITHSONIAN MISCELLANEOUS COLLECTIONS
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In volume 6, Annals of the Smithsonian Astrophysical Observatory, revised 10-day and monthly mean values of the solar constant of radiation, August 1920 to September 1939, were given in table 27. From these data 14 regular periodic variations of the sun's output of radiation were discovered as stated on page 181. These periodic variations are set down in table 32, as they progressed from 1920 to 1939. They were synthesized to give the curve marked B in figure 14. This synthetic curve was produced forward, through 1945, as a prophecy. There was satisfactory verification until late in 1944. Great interest was taken in the march of the prophetic curve in the years 1944 and 1945, for it indicated a considerable depression, somewhat like that observed in 1922 and 1923, as shown in greater detail in figure 12 of the Annals.

L. B. Aldrich, Director of the Observatory, having now kindly given me the solar-constant observations up to the end of 1945 in final form, I wished to see if the great depression occurred in 1945 as expected, and whether the prophecy was generally fulfilled within experimental error.

It is to be regretted that the long series of solar-constant values, 1920 to 1945, has several less satisfactory intervals. First, as stated on page 168 of the Annals, volume 6, was the critical interval 1921 and 1922. At Montezuma (our best station), as may be seen by referring to volume 5 of the Annals, pages 195 to 199, on the average only 3.4 days per decade were observed there from December 21, 1920, to February 28, 1923.

The excellent station on Mount Saint Katherine, in Egypt, where observations were made from January 1934 to November 1937, had to be abandoned because of wars. Hence no support to Montezuma work came from there from 1938 to 1945.

The station at Tyrone, in New Mexico, from which observations came after February 1939, fell more and more behind our hopes as time went on. One disturbing factor was variable smoke arising from increased mining and smelting operations in the surrounding region. The station was closed in 1946. In table 1, which follows, only Table Mountain and Montezuma values are given, omitting Tyrone.

The Montezuma values are weaker than usual in 1939 and throughout 1940. Meteorological conditions at Table Mountain are inferior to those at Montezuma, especially in the months March to June, inclusive, as shown by figure 7, Annals, volume 5, so that intervals of weakness at Montezuma cannot be fully corrected by Table Mountain results.

With these explanations I now give in table 1 the 10-day and monthly mean values of the solar constant of radiation from October 1939 to December 1945. The individual days' results were thoroughly gone over by Messrs. Aldrich and Hoover and Mrs. Bond, of the Observatory staff, and all the individual observations were scrutinized with all the care that long experience suggests. All the statistical evidences as to accuracy and the methods of checking and correction, as described in volume 6 of the Annals, were employed, except that the spectroscopic method of getting "improved preferred" values, as described at pages 166 and 167 of volume 6 of the Annals was not used. In table 1 are given the year and month in the first column; in the second and third columns the mean decade and monthly values from Table Mountain (T) and Montezuma (M). For each month the monthly means follow the three decade means. In the fourth column are given the preferred mean values for decades and for months. To save printing, only the last two figures are given, so that all values are to be understood as prefixed by 1.9. For example, for October 1939, 43 means 1.943 in calories per square centimeter per minute, at mean solar distance, outside the earth's atmosphere. I do not give here the number of days of observation for individual decades at the two stations. However, in computing "preferred mean" values these data, and also the grade of the observations at the two stations, were considered.

It was immediately apparent that though there is fair agreement between prophecy and observation up to near the end of 1944, the large depression of solar-constant values, prophesied from 1939 to occur in 1945, did not occur. I thought it might be because the master period of 273 months was incomplete in 1939. I therefore used the additional values 1939 to 1945 with those preceding, as given in table 27, Annals, volume 6, to make an entirely new analysis, after the manner described in pages 178 to 182 of Annals, volume 6. After tabulating the values for each periodicity in several successive groups, covering respectively successive intervals of time in order to test the

TABLE 1.—*Ten-day and monthly means, 1939 to 1945, from Table Mountain and Montezuma, and preferred values*

1939	T	M	Pfd. mean	1941	T	M	Pfd. mean	1942	T	M	Pfd. mean	1943	T	M	Pfd. mean	1944	T	M	Pfd. mean
Oct.	..	43	43	Jan.	38	51	45	Apr.	—	42	42	July	49	48	48	Oct.	44	47	46
	51	41	46		39	52	46		53	46	49		43	46	45		34	43	39
	54	37	45		36	..	(40)		61	42	51		50	50	50		49	36	42
	52	40	45		38	51	44		57	44	47		47	48	48		41	42	42
Nov.	54	38	46	Feb.	38	52	45	May	43	42	42	Aug.	48	47	47	Nov.	44	47	46
	54	39	46		..	..	(49)		58	49	53		46	48	47		..	45	45
	48	40	44		45	61	53		61	48	54		53	53	53		44	46	45
	53	39	45		39	56	49		50	47	50		50	49	49		44	46	45
Dec.	52	38	45	Mar.	..	55	(50)	June	53	48	50	Sept.	43	47	45	Dec.	45	42	43
	55	46	49		38	54	50		53	48	50		52	50	51		..	41	41
	52	44	48		47	54	51		54	46	50		50	47	48		39	45	42
	54	43	47		41	54	50		53	47	50		47	48	48		42	43	42
1940 Jan.	..	46	46	Apr.	36	50	43	July	48	49	49	Oct.	39	45	42	1945 Jan.	46	..	46
	48	42	45		46	55	51		56	49	52		52	46	49		30	43	37
	..	47	47		23	52	(49)		42	46	44		48	44	47		..	44	44
	48	46	46		37	52	48		48	48	48		49	45	46		33	44	42
Feb.	42	44	43	May	38	56	47	Aug.	41	45	43	Nov.	42	49	46	Feb.	34	48	41
	44	43	43		46	..	(46)		48	46	47		45	39	42		50	45	47
	52	41	46		56	60	58		42	44	43		37	41	39		37	48	43
	46	43	44		43	58	50		44	45	44		41	46	42		40	46	44
Mar.	46	47	47	June	44	59	52	Sept.	46	45	45	Dec.	44	45	45	Mar.	19	46	46
	54	37	45		43	58	51		34	44	39		42	42	42		..	46	46
	36	40	38		52	50	51		46	48	47		46	52	49		..	41	41
	44	41	43		47	56	51		41	46	44		44	49	45		19	45	45
Apr.	..	44	44	July	42	62	52	Oct.	42	47	45	1944 Jan.	54	44	49	Apr.	..	45	45
	42	47	45		48	56	52		46	44	45		48	..	48		..	49	49
	45	55	50		52	55	54		49	46	47		47	44	45		..	49	49
	42	50	46		47	57	53		46	45	46		51	44	47		..	48	48
May	38	51	45	Aug.	50	57	54	Nov.	48	44	46	Feb.	55	46	50	May	..	47	47
	40	49	45		44	55	50		50	48	49		54	36	45		42	45	44
	47	51	49		47	47	47		47	53	50		56	..	(56)		44	48	46
	42	50	46		46	53	50		49	48	49		55	41	50		44	47	46
June	44	50	47	Sept.	53	54	54	Dec.	47	47	47	Mar.	52	38	45	June	36	47	42
	41	49	45		50	51	51		38	41	40		58	38	48		41	44	43
	41	54	48		41	51	46		39	45	42		55	37	46		15	42	42
	42	51	47		48	53	50		40	45	43		55	37	46		37	44	42
July	43	52	48	Oct.	50	54	52	1943 Jan.	39	42	41	Apr.	48	39	43	July	..	50	50
	44	55	50		..	46	46		36	43	40		54	43	48		36	47	42
	45	51	48		45	51	48		..	44	44		48	43	45		29	48	48
	44	53	49		50	50	49		37	43	42		49	42	45		35	48	47
Aug.	46	51	49	Nov.	52	55	54	Feb.	46	..	(46)	May	46	46	46	Aug.	37	50	44
	39	48	44		53	47	50		43	49	46		56	44	50		41	42	42
	43	50	47		55	49	52		41	43	42		..	44	44		..	30	(40)
	42	49	47		53	50	52		43	47	45		48	45	47		40	41	42
Sept.	47	55	51	Dec.	51	53	52	Mar.	40	45	43	June	49	44	46	Sept.	..	40	40
	49	55	52		56	49	52		43	52	48		46	43	44		36	43	40
	39	47	43		..	55	55		46	44	45		42	44	43		47	42	44
	46	52	49		53	53	53		43	46	45		45	44	44		44	41	41
Oct.	46	45	45	1942 Jan.	48	58	53	Apr.	30	43	37	July	49	40	44	Oct.	50	44	47
	37	47	42		43	54	49		41	44	43		44	44	44		42	39	40
	48	49	49		54	51	52		50	46	48		48	41	44		53	32	42
	43	48	45		47	55	51		45	44	43		48	42	44		48	39	43
Nov.	50	45	47	Feb.	49	50	50	May	46	46	46	Aug.	52	46	49	Nov.	51	49	50
	..	45	45		50	50	50		30	47	47		44	39	41		54	41	47
	41	42	42		44	46	45		..	46	46		52	32	42		52	46	49
	45	44	45		47	49	48		38	47	46		51	40	44		51	45	49
Dec.	45	45	45	Mar.	44	41	42	June	43	48	46	Sept.	35	39	37	Dec.	49	40	43
	..	50	50		52	41	46		50	50	50		52	33	42		54	41	44
	44	45	45		46	48	47		55	50	52		40	34	37		55	39	44
	45	47	47		47	43	45		50	49	49		42	37	39		52	40	44

continuity of a supposed periodicity, I found it seemed indicated that some changes should be made from the schedule of periodicities given at page 181 of Annals, volume 6. For comparison I repeat here in table 2, table 31 from that source, with two additional lines to show the modifications found to be desirable. The amplitudes given in the lowest line of table 2 relate to the second of two analyses which I made of the data, as about to be described.

Two complete analyses of the data were computed, of which I give here only the second. The first started with August 1920. In making it, two curves were drawn at the end. In one the sums of the effects of 14 periodicities were used. In the other curve the best representation that I could make of Aldrich's determination [1] of the effect of sunspots on the solar constant was added to them. Neither of these curves fitted the solar-constant results of 1945. The great depression showed by the synthetic curves did not occur in the observations.

It may very well be that the great depression in the observed values, shown in figure 14, Annals, volume 6, in the years 1922 and 1923, is real, and is a fortuitous phenomenon, not included in the sun's ordinary course of variation as represented by the periodicities related to the 273-month master period; or it may be due to a long periodicity like $45\frac{1}{2}$ or 91 years. Possibly, on the other hand, the defective observations at Montezuma, and unsatisfactory sky conditions at Harqua Hala may have been the cause of the great observed depression. In short, possibly it was erroneous, though it is difficult to accept this view as appears from the Annals, volume 6, page 176.

I made a second analysis. Omitting the questionable interval, I started in the middle of the year 1923, and ended with December 1945. Before giving the results of this second analysis I shall give illustrative examples. First I show my method. Then I shall show that individual periodicities continue throughout the entire period. Finally I shall show why certain periodicities found in the earlier 1939 analysis are now omitted, and others substituted.

Figure 1 gives a facsimile reproduction of the computation of the periodicity of $11\frac{1}{4}$ months for the interval May 1923 to September 1945. Although not quite identical, the three sections of the computation agree in supporting the continuing reality of this period of $11\frac{1}{4}$ months.

The reason for introducing the periodicity of 16 months is that I had found it in the residual curve C of figure 14, Annals, volume 6.[2] It is not an important periodicity, but I think a real one.

[1] Smithsonian Misc. Coll., vol. 104, No. 12, 1945.

[2] See Science, May 11, 1945, p. 483.

The reason for omitting periodicities of 21 and 25 months, and inserting one of $22\frac{1}{2}$ months, is that in the present analysis the periodicities of 21 and 25 months failed to persist without change of phase

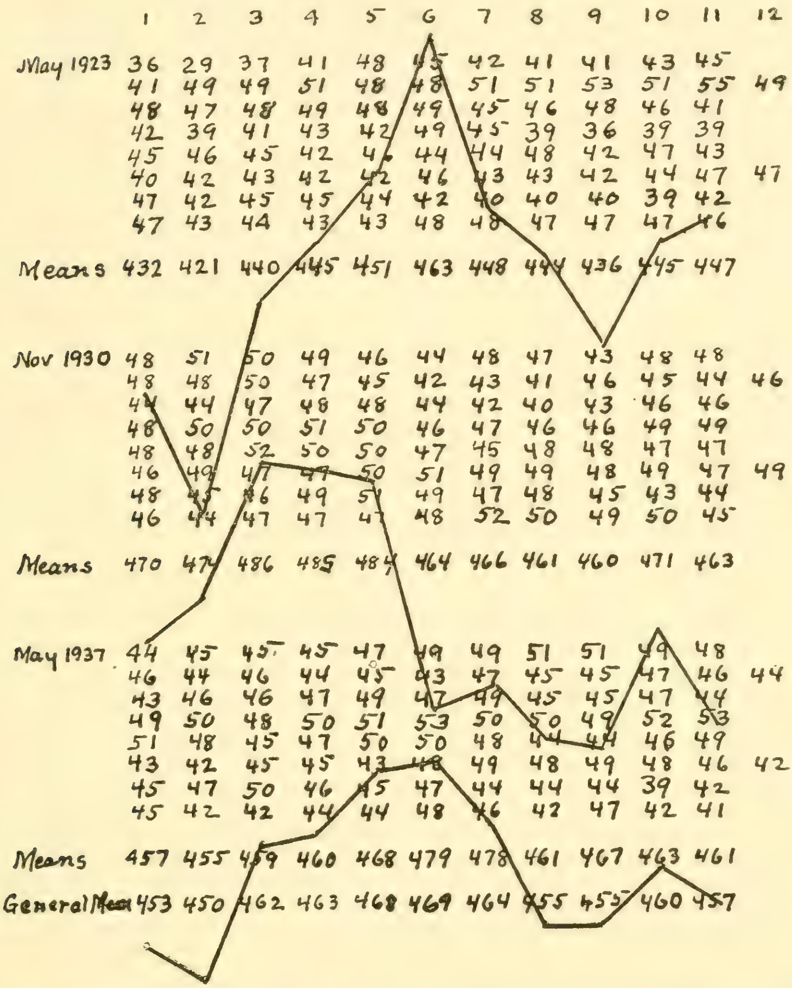


FIG. 1.—Computation of $11\frac{1}{4}$-month periodic variation of the solar constant, with graphs of three general means, 1923 to 1930, 1930 to 1937, and 1937 to 1945.

from 1923 to 1945, but that of $22\frac{1}{2}$ months did seem to persist throughout.

At this point I may say that since some periodicities are nearly integral multiples of others, and since, indeed, the longer periodicities may be obscured in the data, unless the shorter ones are first removed

TABLE 2.—*Long solar periodicities related approximately to 273 months*

		1	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{5}$	$\frac{1}{6}$	$\frac{1}{7}$	$\frac{1}{8}$	$\frac{1}{9}$	$\frac{1}{11}$	$\frac{1}{12}$	$\frac{1}{13}$	$\frac{1}{17}$	$\frac{1}{23}$	$\frac{1}{24}$	$\frac{1}{28}$	$\frac{1}{34}$	$\frac{1}{45}$
Integral ratio..........		1	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{5}$	$\frac{1}{6}$	$\frac{1}{7}$	$\frac{1}{8}$	$\frac{1}{9}$	$\frac{1}{11}$	$\frac{1}{12}$	$\frac{1}{13}$	$\frac{1}{17}$	$\frac{1}{23}$	$\frac{1}{24}$	$\frac{1}{28}$	$\frac{1}{34}$	$\frac{1}{45}$
Fraction of 273 months		273	91	$68\frac{1}{4}$	$54\frac{3}{5}$	$45\frac{1}{2}$	39	$34\frac{1}{8}$	$30\frac{1}{3}$	$24\frac{9}{11}$	$22\frac{3}{4}$	21	$16\frac{1}{17}$	11.87	11.36	9.75	8.03	6.07
Preferred length..	1939	273	91	68	54	$45\frac{1}{4}$	$39\frac{1}{2}$	34	$30\frac{1}{3}$	$25\frac{1}{3}$	....	21	....	11.87	11.29	9.79	$8\frac{1}{8}$	.....
	1945	273	91	68	$54\frac{1}{2}$	....	$39\frac{1}{2}$	34	$30\frac{1}{3}$	....	$22\frac{1}{2}$	....	16	$11\frac{7}{8}$	$11\frac{1}{4}$	$9\frac{3}{4}$	$8\frac{1}{8}$	$6\frac{1}{16}$
Amplitude	1939	90	52	66	55	69	82	56	38	44	....	48	....	34	31	13	18	.....
in $\left(\frac{\text{calories}}{10{,}000}\right)$	1945	44	63	56	26	....	41	40	18	....	21	....	18	22	21	13	18	14

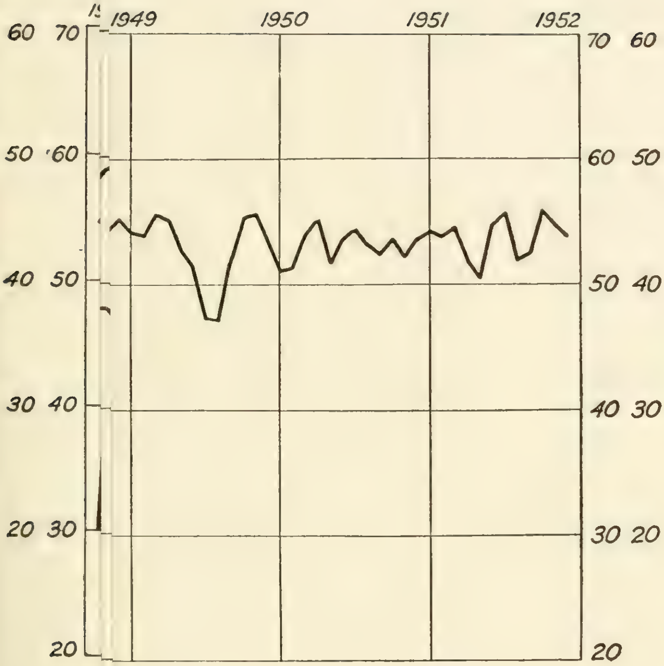
from the data, I proceeded in the following manner in the present analysis. Having computed the average characteristics of the periodicities of $8\frac{1}{8}$, $9\frac{3}{4}$, $11\frac{1}{4}$, and $11\frac{7}{8}$ months, I added their effects together for all months from 1923 to 1945, and subtracted the sums from the original data. I then used these revised residual data to compute for 16 months, 21 months, and $25\frac{1}{3}$ months. But as neither 21 nor $25\frac{1}{3}$ months proved satisfactory, I rejected them in favor of $22\frac{1}{2}$ months. Then I removed the joint effects of 16- and $22\frac{1}{2}$-month periodicities, to give a second type of residual data. From these residual data I computed for $30\frac{1}{3}$ months, removed its effects, and in each succeeding case used residual data from which the effects of all lesser periods had been removed. Arriving at $45\frac{1}{2}$ months, I found its range too small to be considered, and rejected it.

Arrived at 91 months, after computing this periodicity a very definite and persistent periodicity of about 6 months was for the first time disclosed as a sort of nuisance rider on the 91-month periodicity. I thought to remove it by computing such a period from the data as they stood before computing for 91 months. The effects of all periods up to and including 68 months had been removed. The result of this computation showed that a period of 6-1/16 months did in fact persist from 1923 to 1945, but its effect could not be fully removed. It had larger residual amplitudes in the latter part of the computed curve for 91 months. In other words the 6-1/16-month periodicity is of variable amplitude, and is really a subordinate feature of the 91-month periodicity. I had to content myself, unwillingly, with removing it in part as just stated and leaving it in, in part, as a feature of the 91-month periodicity. The part left in still appears as a nuisance rider in the 91-month periodicity, and makes that periodicity a very irregular thing. Instead of being represented by a fairly smoothly flowing curve like all the others, this periodicity has a succession of ups and downs. But I saw no way to avoid it. The period of 273 months is very smooth after the removal of 6-1/16- and 91-month effects.

All the periodic terms were tabulated and summed up after the manner of table 32, volume 6 of the Annals. The summation of them having been added in each month to a constant term 1.9462, there resulted a curve which could be compared with the original data, and which could be continued by way of prophecy backward from the middle of 1923 to August 1920, and forward from January 1946 to December 1951, as shown in figure 2. I give in table 3 the prophecy, 1946 to 1951, to show the forms and magnitudes of the several periodicities.

TABLE 3.—*Synthesis of periodicities, 1946 to 1951*

	$6\frac{1}{16}$	$8\frac{1}{8}$	$9\frac{3}{4}$	$11\frac{1}{4}$	$11\frac{7}{8}$	16	$22\frac{1}{2}$	$30\frac{1}{3}$	34	$39\frac{1}{2}$	$54\frac{1}{2}$	68	91	273	
1946-I	−1	5	−3	3	−6	−6	6	−5	−5	−16	−6	−21	−3	−8	39.6
II	3	10	2	8	−10	−5	3	−6	−17	−20	−9	−18	−33	−8	36.2
III	7	−8	7	12	−11	−2	0	−4	−17	−23	−13	−14	−20	−8	36.8
IV	−1	−7	6	6	−5	3	−2	2	−12	−22	−14	−11	−10	−9	38.6
V	−7	−5	0	−2	0	8	−4	7	−8	−20	−13	−8	7	−9	40.8
VI	2	−2	−5	−6	0	8	−6	10	−4	−16	−10	−4	10	−10	42.9
VII	−1	1	−6	−3	0	2	−9	9	−6	−9	−9	−2	−3	−11	41.5
VIII	3	2	−6	−4	2	−5	−11	6	−11	−6	−9	0	−17	−11	39.5
IX	7	5	−4	−5	2	−8	−10	3	−20	−3	−8	2	−3	−12	40.8
X	−1	10	−2	−9	6	−6	3	0	−17	−2	−8	5	−2	−13	42.6
XI	−7	−8	−3	−4	11	0	2	−2	−9	−2	−7	7	−1	−12	39.1
XII	2	−7	2	3	5	2	−3	−4	0	−2	−5	8	0	−13	45.0
1947-I	−1	−5	7	8	−6	3	−4	−6	−6	−2	−3	10	3	−13	44.7
II	3	−2	6	12	−10	5	−3	−7	0	0	1	13	4	−13	47.1
III	7	1	0	6	−11	10	−1	−8	6	1	5	15	6	−13	48.6
IV	−1	2	−5	−2	−5	−3	1	−8	8	3	8	17	8	−14	47.1
V	−7	5	−6	−6	0	−6	3	−7	12	6	9	20	10	−14	48.1
VI	2	10	−6	−3	0	−5	6	−5	7	8	7	22	11	−14	50.2
VII	−1	−8	−4	−4	0	−2	8	−3	12	10	5	24	12	−14	49.7
VIII	3	−7	−2	−5	2	3	9	−2	20	13	3	22	0	−14	50.7
IX	7	−5	−3	−9	2	8	10	0	11	14	3	20	−10	−15	49.5
X	−1	−2	2	−4	6	8	8	1	4	16	4	17	7	−15	51.3
XI	−7	1	7	3	11	2	6	2	−4	17	5	16	10	−15	51.6
XII	2	2	6	8	5	−5	3	3	5	18	8	15	17	−16	53.3
1948-I	−1	5	0	12	−6	−8	0	3	12	18	10	14	20	−16	52.5
II	3	10	−5	6	−10	−6	−2	2	11	17	11	13	23	−16	51.9
III	7	−8	−6	−2	−11	0	−4	2	0	17	12	13	3	−17	46.8
IV	−1	−7	−6	−6	−5	2	−6	0	−5	17	11	12	−3	−17	44.8
V	−7	−5	−4	−3	0	3	−9	−1	−4	16	8	12	−10	−17	44.1
VI	2	−2	−3	−4	0	5	−11	−2	4	16	6	12	−7	−17	46.1
VII	−1	1	2	−5	0	10	−10	−4	−2	14	5	11	23	−17	48.9
VIII	3	2	7	−9	2	−3	3	−5	−3	12	3	11	27	−17	49.5
IX	7	5	6	−4	2	−6	2	−6	−5	9	2	11	7	−18	47.4
X	−1	10	0	3	6	−5	−3	−4	−5	6	1	10	7	−18	46.9
XI	−7	−8	−5	8	11	−2	−4	2	−5	4	0	10	−7	−18	44.1
XII	2	−7	−6	12	5	3	−3	7	−17	2	−2	11	0	−18	45.1
1949-I	−1	−5	−4	6	−6	8	−1	10	−17	0	−3	10	0	−18	44.1
II	3	−2	−2	−2	−10	8	1	9	−12	−2	−4	8	0	−18	43.9
III	7	1	−3	−6	−11	2	3	6	−8	−6	−6	6	27	−18	45.6
IV	−1	2	2	−3	−5	−5	6	3	−4	−10	−8	4	25	−18	45.1
V	−7	5	7	−4	0	−8	8	0	−6	−16	−9	1	12	−18	42.7
VI	2	10	6	−5	0	−6	9	−2	−11	−20	−10	−1	0	−19	41.5
VII	−1	−8	0	−9	0	0	10	−4	−20	−23	−10	−3	−2	−19	37.3
VIII	3	−7	−5	−4	2	2	8	−6	−17	−22	−9	−4	−13	−19	37.1
IX	7	−5	−6	3	2	3	7	−7	−9	−20	−9	−5	13	−19	41.7
X	−1	−2	−6	8	6	5	6	−8	0	−16	−6	−7	30	−19	45.2
XI	−7	1	−4	12	11	10	3	−8	−6	−9	−3	−8	20	−19	45.5
XII	2	2	−2	6	5	−3	0	−7	0	−6	1	−10	3	−20	43.3
1950-I	−1	5	−3	−2	−6	−6	−2	−5	6	−3	3	−12	−7	−20	40.9
II	3	10	2	−6	−11	−5	−4	−3	8	−2	4	−13	−13	−20	41.2
III	7	−8	7	−3	−5	−2	−6	−2	12	−2	5	−14	7	−20	43.8
IV	−1	−7	6	−4	0	3	−9	0	7	−2	5	−15	27	−20	45.2
V	−7	−5	0	−5	0	8	−11	1	12	−2	3	−15	−5	−20	41.6
VI	2	−2	−5	−9	0	8	−10	2	20	0	1	−14	0	−20	43.5
VII	−1	1	−6	−4	2	2	3	3	11	1	−2	−13	4	−20	44.3
VIII	3	2	−6	−5	2	−5	2	3	4	3	−6	−12	4	−20	43.1
IX	7	5	−4	−9	6	−8	−3	2	−4	6	−9	−12	5	−20	42.4
X	−1	10	−2	−6	11	−6	−4	2	5	8	−13	−11	0	−20	43.5
XI	−7	−8	−3	−4	5	0	−3	0	12	10	−14	−12	3	−20	42.1
XII	2	−7	2	3	−6	2	−1	−2	11	13	−13	−13	3	−20	43.6
1951-I	−1	−5	7	8	−10	3	1	−4	0	14	−10	−15	12	−20	44.2
II	3	−2	6	12	−11	5	3	−4	−5	16	−9	−18	0	−20	43.8
III	7	1	0	6	−5	10	6	−5	−4	17	−9	−22	0	−19	44.5
IV	−1	2	−5	−2	0	−3	8	−6	4	18	−8	−25	−5	−19	42.0
V	−7	3	−6	−6	0	−6	9	−4	−2	18	−8	−29	0	−19	40.5
VI	2	5	−6	−3	0	−5	10	2	−3	18	−7	−32	23	−19	44.7
VII	−1	10	−4	−4	2	−2	8	7	−5	17	−5	−29	20	−19	45.7
VIII	3	−8	−3	−5	2	3	6	10	−5	17	−3	−25	−17	−18	41.9
IX	7	−7	2	−9	6	8	3	9	−5	16	1	−21	−30	−18	42.4
X	−1	−5	7	−4	11	8	0	6	−17	16	5	−18	7	−18	45.9
XI	−7	−2	6	3	5	2	−2	3	−17	14	8	−14	3	−17	44.7
XII	2	1	0	8	−6	−5	−4	0	−12	12	9	−11	0	−17	43.9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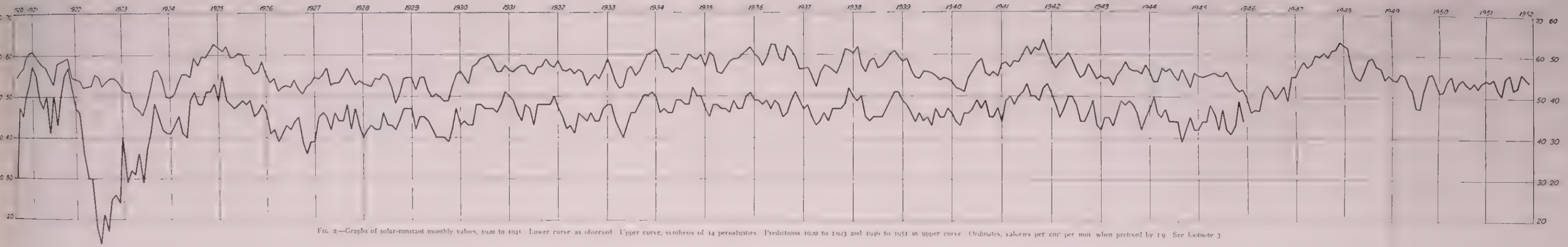

FIG. 2—Graphs of solar-constant monthly values, 1920 to 1945. Lower curve as observed. Upper curve, synthesis of 14 periodicities. Predictions 1920 to 1923 and 1946 to 1951 in upper curve. Ordinates, calories per cm² per min. when prefixed by 1.9. See footnote 3.

The average deviation between observed and synthetic curves, taken without regard to sign, from the middle of 1923 to the end of 1945, is 0.00177 calorie, or 0.081 percent of the solar constant.[3] This very surprisingly satisfactory fit between the observed and the synthetic curves seems to me to support my action with respect to the 91-month periodicity, as described above. For this period repeats three times. If the increasing importance of the unremoved part of the 6-1/16-month period toward the latter part of the 91-month periodicity was spurious, and caused by some large irregularity in a few years, then it would not be expected that to include these large ups and downs in the 91-month periodicity would so precisely satisfy the original observations, right through the entire interval 1923 to 1945. Following the prophetic curve back from 1923 to 1920, the great depression of the observed curve in 1922 is not found in the prophetic curve. But the principal features observed in 1920 and 1921 are well indicated in the prophetic curve. It will be of great interest to compare the observations, when they become available, with the prophetic curve from 1946 to 1951.

It is impossible at present to be certain whether the failure to follow the observations in 1922 is caused by defective observations, as already suggested, or by a deviation of the sun's output of radiation, at that time, from its normal course, which may represent a feature of a longer periodicity, such as $45\frac{1}{2}$ or 91 years.

The system of long-range solar periodicities that I now prefer is given in the lines marked "1945" of table 2. Like the curve of the sunspot cycle of $11\frac{1}{3}$ years, the curves of these periodicities in the solar constant are not regular sine curves, but their forms are given by the tabulations, as in figure 1 and table 3. I see no advantage in forcing them to conform to Fourier's series procedures.

[3] It will be noted that the curves of figure 2 come too close together at the end of 1945. As this paper was in press, work on the 1946 observations reached a stage which showed something wrong at Table Mountain. If Montezuma results Oct.–Dec., 1946, are used alone, the anomaly disappears.

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(With Two Plates)

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The identification of the larger neotropical Dictyopharidae is at present difficult for workers who do not have access to holotype material. The main difficulty arises from the fact that early descriptions failed to give an adequate account of the specific characters.

The notes that follow are principally concerned with holotype material of neotropical Dictyopharidae in the collection of the British Museum of Natural History. It is hoped that they will facilitate identification and enable the reader to recognize and correct errors in existing literature. The writer regrets that it has not proved possible to give a series of figures of genitalia; the holotypes are of different sexes and such a study must await the assembly of material of each species belonging to the same sex. He is nevertheless confident that the characters described below provide reliable criteria for the separation of species.

Family DICTYOPHARIDAE

Tribe DICHOPTERINI

Genus DIACIRA Walker

Diacira Walker, 1858, Insecta Saundersiana, p. 34. (Haplotype, *D. varia* Walker, ibid.)

The type of *D. varia* agrees fairly well with the description and figures given by Spinola (Ann. Soc. Ent. France, vol. 8, p. 318, pl. 13, figs. 1a-b) of *Cladodiptera macrophthalma* Spinola, the genotype of *Cladodiptera*. The profemora and protibiae of Walker's type, however, are prominently leaflike, while Spinola does not show or describe any such structure in *C. macrophthalma*. If *Diacira* is to be retained as separate from *Cladodiptera*, this may have to be taken as the generic difference. The species of *Diacira* as so defined show variation in the width of the flanges on the forelegs, and it must be considered possible that further work will bring to light a complete series of intergradations.

Tribe DICTYOPHARINI

Genus HYDRIENA Melichar

Hydriena Melichar, 1912, Abh. Zool. Bot. Ges. Wien, vol. 7, No. 1, p. 50. (Orthotype, *H. distanti* Melichar, ibid.)

HYDRIENA FERRUGINEA (Walker), new combination

Plate 2, figures 24-26

Dichoptera ferruginea Walker, 1851, List Hom., vol. 2, p. 305.
Hydriena distanti Melichar, 1912, Abh. Zool. Bot. Ges. Wien, vol. 7, No. 1, p. 50.

Post-tibiae with 5 spines. Tegmina with M forked once in corium; stigma 4-celled; 3 rows of areoles in membrane, 18 areoles along apical margin.

The figures are of Walker's holotype.

Genus MEGADICTYA Melichar

Megadictya Melichar, 1912, Abh. Zool. Bot. Ges. Wien, vol. 7, No. 1, p. 64. (Orthotype, *M. multispinosa* Melichar, ibid.)

MEGADICTYA OBTUSIFRONS (Walker), new combination

Plate 2, figures 21-23

Dictyophara obtusifrons Walker, 1851, List Hom., vol. 2, p. 318.
Megadictya multispinosa Melichar, 1812, Abh. Zool. Bot. Ges. Wien, vol. 7, No. 1, p. 64.

Vertex conical in outline, longer than broad (1.1 : 1). Post-tibiae with 5 spines. Tegmina about 13 mm. long, corium occupying less than half of total area; M 3+4 forked before nodal line, stigma 6- or 7-celled; 10 rows of transverse veins distad of nodal line, 22 areoles along apical margin. Pygofer with a straight slender spine at dorsal ends of posterior margin, directed posteriorly and downward.

The figures and data are based on Walker's holotype.

The discovery of the true generic position of *D. obtusifrons* was most unexpected, as the species figured under this name in the Biologia Centrali-Americana is a characteristic *Hyalodictyon.* Careful comparison of Walker's description with the holotype leaves no doubt of their perfect agreement. Among other characters Walker mentions a "short luteous stripe" along the lateral margin of the prothorax; the type has an opaque yellowish stripe in this position, which, through decay of the body contents, has practically disappeared along the anterior half of its length.

The species figured under this name in the Biologia Centrali-Americana is dealt with below under *Hyalodictyon.*

Genus LAPPIDA Amyot and Serville

Lappida AMYOT and SERVILLE, 1843, Hist. Nat. Ins. Hemipt., p. 505. (Haplotype, *Dictyophara proboscidea* Amyot and Serville, ibid.)

LAPPIDA FEROCULA (Distant)

Dictyophara ferocula DISTANT, 1887, Biol. Centr.-Amer., Rhynch. Hom., vol. 1, p. 40, pl. 6, fig. 2.

To judge from the type this would appear to be the largest species in the genus. The type of *Dictyophara chlorochroma* Walker (List Hom., vol. 2, p. 311, 1851) is similar but smaller, while that of *D. compressifrons* Walker (List Hom. Suppl., p. 62, 1858) is smaller than *chlorochroma* and probably distinct. The writer cannot endorse the existing synonymy of these species with any confidence.

LAPPIDA TUMIDIFRONS (Walker), new combination

Dictyophara tumidifrons WALKER, 1858, List Hom. Suppl., p. 65.

This species stands well apart from others in its short cephalic process. Tegmina narrow, M forked at level of apex of clavus, stigma 1- or 2-celled, 3 rows of transverse veins, infuscate, 17 apical areoles, apical veins and a cloud in membrane near stigma infuscate.

Genus DICTYOPHAROIDES Fowler

Dictyopharoides FOWLER, 1900, Biol. Centr.-Amer., Rhynch. Hom., vol. 1, p. 44. (Haplotype, *D. tenuirostris* Fowler, ibid.)

Melichar and his followers have suppressed *Dictyophara telifera* Walker under *Toropa ferrifera* (Walker); *Dictyophara filifera* Walker and *D. rufistigma* Walker are currently retained in their original genus. These species, however, all belong to quite different genera, separated by characters given in the following key, which may be related to the writer's key to the New World Dictyopharini (Proc. Biol. Soc. Washington, vol. 57, p. 80, 1944) by substituting it for the name *Dictyopharoides* in that key.

(1) (2) Clypeus about as large as frons, tegmina with 3 rows of regularly arranged areoles in membrane; eye viewed from above 1.5 times width of vertex, tegmina with M arising from R at base............................*Neomiasa,* new genus
(2) (1) Clypeus not nearly as large as frons, tegmina with veins of membrane more or less irregular..............................(3)
(3) (4) Tegmina semicircularly rounded apically, cells of membrane not or scarcely longer than broad..........*Dictyopharoides* Fowler
(4) (3) Tegmina more deeply rounded than above, M forming a common stalk with R for some distance, all cells of membrane much longer than broad, if not, then apical margin abruptly indented in M. Eye in dorsal view equal to width of vertex ....*Paramisia* Melichar

Genus PARAMISIA Melichar

Paramisia Melichar, 1912, Abh. Zool. Bot. Ges. Wien, vol. 7, No. 1, p. 79. (Orthotype, *P. suturata* Melichar, ibid.)

Width of eye viewed from above equal to width of vertex. Tegmina with stigma 2- or 4-celled, M markedly stalked with R for some distance, apex of tegmen deeply rounded, sometimes abruptly emarginate in M.

PARAMISIA RUFISTIGMA (Walker), new combination

Dictyophara rufistigma Walker, 1851, List Hom., vol. 2, p. 313.
Dictyophara sulcirostris Berg, 1879, An. Soc. Cient. Argentina, vol. 8, p. 182.

A male specimen of *D. sulcirostris* Berg (labeled Colon, Montevideo 15. v. 96 O. Thomas coll. 1909-337) was found to agree with the female type of *D. rufistigma* Walker, differing only in having an extra cell in the stigma.

PARAMISIA FILIFERA (Walker), new combination

Plate 2, figures 32-35

Dictyophara filifera Walker, 1858, List Hom. Suppl., p. 64.

Pronotal disc tricarinate, distinctly raised and acute anteriorly. Tegmina with stigma 3-celled, apical margin sharply indented in cell M 3.

Frons with a piceous spot on each side of base of cephalic process. Tegmina with stigma green, membrane evenly brown, with a V-shaped hyaline area extending inward across cell M 3.

The description and figures are of the type. The shape of the tegmina is generally similar to that of the African *Raphiophora,* but the two are not congeneric.

NEOMIASA, new genus

Vertex in profile strongly convex, longer than broad (2.6:1), cephalic process about 2.2 times as long as eye. Eye viewed from above 1.5 times width of vertex. Frons longer than broad (1.7:1), lateral margins straight, diverging distally, abruptly incurved just before apex. Width across frontoclypeal suture about three times width across base; clypeus almost as large as frons, lateral margins converging distally; cephalic process in same plane as frons. Pronotum anteriorly convex, posteriorly broadly emarginate, disc devoid of carinae, in form of a rounded-tumid elevation; mesonotum obsoletely carinate or ecarinate. Protibiae slender and elongate, posttibiae 4-spined.

Tegmina semicircularly rounded apically, M forked once in corium, stigma 1- to 2-celled, 2 or 3 rows of transverse veins, about 19 areoles along apical margin.

Egg ellipsoidal, a short filiform process at one pole.

Genotype.—Dictyophara telifera Walker.

This genus differs from *Paramisia* Melichar in M arising from R at base, vertex in profile more strongly convex, pronotum and mesonotum relatively much broader.

NEOMIASA TELIFERA (Walker)

PLATE 2, FIGURES 27-31

Dictyophara telifera WALKER, 1858, List Hom. Suppl., p. 64.

The figures are of Walker's type. It will be seen that it differs abundantly from *Toropa ferrifera* (Walker) with which it has been synonymized by Melichar.

Genus HYALODICTYON Fennah

Hyalodictyon FENNAH, 1944, Proc. Biol. Soc. Washington, vol. 57, p. 86. (Orthotype, *Dictyophara nodivena* Walker, 1858, Insecta Saundersiana, p. 37.)

The identification of the species ascribed to this genus cannot be undertaken with any confidence from existing literature. The species differ in the shape of the cephalic process and to some extent in size. It is probable that when adequate dissections have been made a classification will also be possible on genital characters.

The main source of confusion has been the assumption by older workers, with the notable exception of Walker, that the species of *Hyalodictyon* (considered as belonging to *Dictyophara* Germar) were more plastic than they are. As a result, a single name has been used to cover a mixture of species, and unjustifiable synonymies have been created. The confusion has been increased by the publication of wrongly labeled figures, and in this respect the Biologia Centrali-Americana is not free from blemish.

To facilitate identification of species of *Hyalodictyon* the writer offers camera-lucida drawings made by him from the respective holotypes in the British Museum. It has been found necessary to propose two new species, the types of which have been selected from material listed in the Biologia.

HYALODICTYON NODIVENA (Walker)

PLATE 1, FIGURES 1-4

Dictyophara nodivena WALKER, 1858, Insecta Saundersiana, p. 37.

This is the largest known species in the genus. The proportions of the frons are distinctive and characteristic. The apical areoles in the tegmina are very short, some of them not longer than broad. The swellings on the veins of the membrane in M do not constitute a specific character, although they are perhaps more evident in this species than in any other.

HYALODICTYON TEAPANUM, new species

PLATE 1, FIGURES 5, 11

Dictyophara nodivena DISTANT, 1887, Biol. Centr.-Amer., Rhynch. Hom., vol. 1, p. 40, pl. 6, fig. 3.

This species, represented by a fair series, is quite distinct from the preceding. The laterodorsal angles of the frons are less obtuse than in *nodivena* Walker, the sides of the frons are distinctly more concave, while the intermediate carinae of the frons are relatively more widely separated at the base. The frons of *nodivena* Walker is actually broader than that of *teapanum* as well as being broader in relation to the median length (*H. nodivena,* 2.4 to 1; *H. teapanum,* 2.5 to 1). The type of *teapanum* is the specimen from Bugaba figured in the Biologia as *D. nodivena* Walker. Among other specimens in the series are some from Teapa.

HYALODICTYON TRUNCATUM (Walker)

PLATE 1, FIGURES 6-10

Dictyophara truncata WALKER, 1851, List Hom., vol. 2, p. 316.

This species is slightly smaller than *nodivena* (Walker), from which it differs strongly in the distinctly narrower frons and more elongated vertex as well as in the relatively longer apical areoles in the tegmen. *H. truncatum* is superficially very similar to *H. teapanum* but differs in having the lateral lobes of the pronotum wider than deep, while in *teapanum* they are deeper than wide. In *truncatum* cell M 1+2 in the corium is much shorter than its stalk, while cell Cu_1 is about as long as its stalk; in *H. teapanum* both these cells are longer than their respective stalks. The stigma of *H. truncatum* is 5-celled.

The most significant difference among the specimens available was found in the shape of the third valvulae of the ovipositor, these of *H. truncatum* being much more slender than in *teapanum* (see figures from holotypes).

HYALODICTYON PLATYRHINA (Walker)

PLATE 1, FIGURE 12

Dictyophara platyrhina WALKER, 1851, List Hom., vol. 2, p. 311.

This species is almost as large as *nodivena* (Walker) from which it differs markedly in the longer vertex and relatively broader and transverse apex. It is nearest in appearance to *H. teapanum,* but the lateroapical angles of the head are more prominent and the anterior margin of the vertex is truncate, not rounded as in the latter species. *H. platyrhina* is the most readily recognizable species in the genus.

HYALODICTYON FUSIFORME (Walker)

PLATE 1, FIGURE 18

Dictyophara fusiformis WALKER, 1851, List Hom., vol. 2, p. 315.

This species is distinguished from all the preceding by the relatively narrower vertex, the obtusely rounded lateroapical angles, and the rounded apical margin. The type is not quite so large as the preceding species.

HYALODICTYON FALLAX Fennah

Hyalodictyon fallax FENNAH, 1945, Proc. U. S. Nat. Mus., vol. 95, p. 456.

This species, as noted in the original description and shown in plate 11, figures 239-242, differs from *H. truncatum* (Walker), which it generally resembles, in the straight sides of the vertex and frons. This distinction has been found to hold good in specimens more recently taken by the writer (2 ♀♀, Maracas pool, Trinidad, Sept. 28, 1945).

HYALODICTYON BUGABAE, new species

PLATE 1, FIGURES 15, 16

Dictyophara obtusifrons DISTANT, 1887, Biol. Centr.-Amer., Rhynch. Hom., vol. 1, p. 40, pl. 6, fig. 6.

The shape of the vertex of this species recalls that of *H. nodivena* (Walker), but its apex is more rounded and the lateroapical angles are less prominent. The frons is relatively narrower and the curve of the intermediate carinae at the base is different. The species is definitely smaller than *H. nodivena.* The type selected is a male taken by Champion (Volcán de Chiriquí, 800-1,500 ft.).

HYALODICTYON BRACHYRHINA (Walker)

PLATE 1, FIGURE 17

Dictyophara brachyrhina WALKER, 1851, List Hom., vol. 2, p. 317.

This species is superficially not unlike *Mitrops dioxys* (Walker) (=*Nersia curviceps* Stål), but naturally these species differ in generic characters. The type of *M. dioxys* (Walker) has narrow elongated third valvulae; *H. brachyrhina* (Walker) has broadly ovate third valvulae three times as broad as in the former. In dorsal view the vertex somewhat resembles that of *Mitrops noctividus* (L.) but in profile it is quite flat, not upturned apically. The margins and carinae in the type of *brachyrhina* are red.

HYALODICTYON CENTRALI-AMERICANUM, new species

PLATE 1, FIGURES 13, 14

Dictyophara brachyrhina DISTANT, 1887, Biol. Centr.-Amer., Rhynch. Hom., vol. 1, p. 40, pl. 6, fig. 5.

Male.—Length, 8.0 mm.; tegmen, 10.0 mm.

Vertex longer than broad (1.8:1) tapering distally, lateral angles not prominent, apex broadly rounded. Frons longer than broad (3.4:1) of subequal width throughout, lateral margins slightly sinuate.

The type male was taken by G. C. Champion at Zapote, Guatemala.

Genus TAOSA Distant

Taosa DISTANT, 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 18, p. 355. (Orthotype, *T. suturalis* Germar, 1830, Thon's Ent. Arch., vol. 2, No. 2, p. 48.)

TAOSA INEXACTA (Walker)

Dictyophara inexacta Walker, 1858, Insecta Saundersiana, p. 38.
Taosa paraherbida Muir, 1931, Proc. Hawaiian Ent. Soc., vol. 7, p. 474, pl. X, fig. 9.

Walker's holotype agrees perfectly with a specimen of *Taosa paraherbida* Muir in the British Museum bearing Muir's paratype label. In view of the fact that the holotype of Muir's species is untraceable, this specimen becomes the residual type. *T. inexacta* (Walker) is not synonymous with *T. herbida* (Walker) as given by Distant, and it is noteworthy that the characteristic difference in the coloration of the frons between these species is clearly stated in Walker's original descriptions.

TAOSA SCRIPTIVENTRIS (Walker)

Plate 2, figures 43, 44

Cladodiptera scriptiventris Walker, 1858, List Hom. Suppl., p. 76.
Taosa pseudoscriptiventris Muir, 1931, Proc. Hawaiian Ent. Soc., vol. 7, p. 472.

The type of *T. pseudoscriptiventris* Muir is not distinguishable from the holotype of *scriptiventris* (Walker) except by a darker suffusion overlying the sutural line, and in its slightly larger size (Muir's type: tegmen, 10 mm.; Walker's type: tegmen, 9 mm.). The two types are female and the genitalia are externally indistinguishable. Specimens in the Biologia Centrali-Americana series of *scriptiventris* (Walker) are larger than either of the preceding but are closely similar, though with rather more extensive brown suffusion on the membrane. These are considered to be geographical representatives of the South American type.

TAOSA VITRATA (Fabricius)

Plate 1, figures 19, 20

Flata vitrata Fabricius, 1803, Syst. Rhyng., p. 48.

Dr. S. L. Tuxen, of the Universitetets Zoologiske Museum, Copenhagen, has kindly prepared drawings from the Fabrician type (reproduced herewith) and has compared with it drawings of the type of *Cladodiptera viridifrons* Walker. The two species are evidently distinct, and the synonymy created by Distant (Biol. Centr.-Amer., Rhynch. Hom., vol. 1, p. 41), followed by Melichar (1912) and Fennah (1945), is erroneous.

TAOSA VIRIDIFRONS (Walker)

Plate 2, figures 41, 42

Cladodiptera viridifrons Walker, 1858, Insecta Saundersiana, p. 41.

The holotype of Walker's series agrees with the insect identified in the Biologia Centrali-Americana (Distant, vol. 1, p. 41, 1887) as *Dictyophara vitrata* (Fabricius). The specimen also agrees with Melichar's description of *Taosa suturalis* Germar (Abh. Zool. Bot. Ges. Wien, vol. 7, No. 1, p. 153, 1912). It is considered to be distinct.

TAOSA MULIEBRIS (Walker)

Plate 2, figures 37, 38

Cladodiptera muliebris Walker, 1858, List Hom. Suppl., p. 76.

This species appears to be quite distinct, and the suppression of it as a synonym of *suturalis* Germar (Muir, 1931) cannot be upheld. The figures are of the holotype.

TAOSA TERMINALIS (Germar)

Plate 2, figures 39, 40

Flata terminalis Germar, 1830, Thon's Ent. Arch., vol. 2, No. 2, p. 48.
Cladodiptera virilis Walker, 1858, List Hom. Suppl., p. 75.

Walker's holotype of *virilis* is figured.

TAOSA SORORCULA (Berg)

Plate 2, figure 36

Dictyophara sororcula Berg, 1879, An. Soc. Cient. Argentina, vol. 8, p. 183.

The figure is based on a specimen in the British Museum.

Genus TARACTICUS Berg

Taracticus Berg, 1881, An. Soc. Cient. Argentina, vol. 12, p. 265. (Orthotype, *Cixius chilensis* Spinola, 1852, *in* Gay, Hist. de Chile, Zool., vol. 7, p. 249.)
Chondrodera Melichar, 1912, Abh. Zool. Bot. Ges. Wien, vol. 7, No. 1, p. 157. (Orthotype, *C. granicollis* Melichar, ibid., p. 158.)

TARACTICUS CHILENSIS (Spinola)

Cixius chilensis Spinola, 1852, loc. cit.
Chondrodera chilensis Melichar, 1912, loc. cit., p. 159.

The writer, on the basis of Chilean material examined by him, considers it necessary to establish the above generic and specific synonymies.

Family TROPIDUCHIDAE

Tribe TAMBINIINI

Genus ROTUNOSA Distant

Rotunosa DISTANT, 1906, Ann. Mag. Nat. Hist. ser. 7, vol. 18, p. 353. (Orthotype, *Dictyophara indicanda* Walker, 1858, List Hom. Suppl., Addenda, p. 318.)

Roesma FENNAH, 1945, Proc. U. S. Nat. Mus., vol. 95, p. 481. (Orthotype, *R. grandis* Fennah, ibid., p. 482.)

ROTUNOSA GRANDIS (Fennah), new combination

Material of *R. grandis* Fennah, when compared with Walker's holotype, proved to be definitely congeneric. The species are quite readily separated by the proportions of the vertex.

Tribe PARICANINI

Genus NEOMMATISSUS Muir

Neommatissus MUIR, 1913, Proc. Hawaiian Ent. Soc., vol. 2, p. 267. (Orthotype, *N. spurcus* Muir, ibid.)

As this genus has been included in a recent catalogue of Dictyopharidae (General Catalogue of Hemiptera, fasc. IV, pt. 8, p. 71), it is advisable to record that the genotype is a paricanine tropiduchid, as are those of the synonymous genera *Stacotoides* Distant and *Trobolophya* Melichar. The species are quite conveniently separated by the venation of the tegmina.

NEOMMATISSUS CONGRUUS (Walker), new combination

PLATE 2, FIGURE 45

Brixia congrua WALKER, 1870, Journ. Linn. Soc. Zool., vol. 10, p. 110.
Neommatissus spurcus MUIR, 1913, Proc. Hawaiian Ent. Soc., vol. 2, p. 267.

Material of *N. spurcus* Muir bearing Muir's determination label cannot be distinguished from the holotype of *Brixia congrua* Walker. The mesonotal carinae are strongly elevated. The figure is from Walker's mutilated holotype.

Family CIXIIDAE

Tribe PINTALIINI

Genus PINTALIA Stål

Pintalia STÅL, 1862, Bidr. Rio-Janeiro Trakt. Hemipt., vol. 2, p. 4. (Logotype, *P. lateralis* Stål, ibid.)

PINTALIA CONSTELLARIS (Walker), new combination

Poeciloptera constellaris WALKER, 1858, List Hom. Suppl., Addenda, p. 335.
Pintalia quadrimaculata FENNAH, 1945, Proc. U. S. Nat. Mus., vol. 96, p. 96, pl. 2, fig. 1.

An examination of Walker's holotype leaves no doubt concerning the synonymy given above.

Tribe CIXIINI

Genus OLIARUS Stål

Oliarus STÅL, 1862, Berlin Ent. Zeitschr., vol. 6, p. 306. (Logotype, *O. walkeri* Stål, 1859, Freg. Eugen. Resa, p. 272.)

OLIARUS VILIS (Walker), new combination

Cixius vilis WALKER, 1857, Journ. Linn. Soc. Zool., vol. 1, p. 148.

Although the head of the female holotype is missing, its description, the size, quinquecarinate mesonotum, tegminal venation, and the characteristic genitalia indicate that this species belongs in *Oliarus*.

EXPLANATION OF PLATES

PLATE 1

FIGS. 1–4. *Hyalodictyon nodivena* (Walker). 1, vertex and pronotum; 2, frons; 3, vertex in profile; 4, apex of tegmen.
5. *Hyalodictyon teapanum* Fennah. Frons.
6–10. *Hyalodictyon truncatum* (Walker). 6, vertex and pronotum; 7, vertex in profile; 8, apex of tegmen; 9, frons; 10, third valvula of ovipositor.
11. *Hyalodictyon teapanum* (Walker). Third valvula of ovipositor.
12. *Hyalodictyon platyrhina* (Walker). Vertex and pronotum.
13, 14. *Hyalodictyon centrali-americanum* Fennah. 13, vertex and pronotum; 14, frons and clypeus.
15, 16. *Hyalodictyon bugabae* Fennah. 15, frons and clypeus; 16, vertex and pronotum.
17. *Hyalodictyon brachyrhina* (Walker). Vertex and pronotum.
18. *Hyalodictyon fusiforme* (Walker). Vertex and pronotum.

19, 20. *Taosa vitrata* (Fabricius). 19, frons and clypeus; 20, vertex and pronotum.

PLATE 2

FIGS. 21–23. *Megadictya obtusifrons* (Walker). 21, vertex and pronotum; 22, frons and clypeus; 23, pygofer, anal segment, and genital style.

24–26. *Hydriena ferruginea* (Walker). 24, vertex in profile; 25, frons and clypeus; 26, vertex and pronotum.

27–31. *Neomiasa telifera* (Walker). 27, egg in frontal and side views; 28, vertex and pronotum; 29, vertex in profile; 30, apical half of tegmen; 31, frons and clypeus.

32–35. *Paramisia filifera* (Walker). 32, vertex in profile; 33, vertex and disc of pronotum; 34, frons and clypeus; 35, apical part of tegmen.

36. *Taosa sororcula* (Berg). Vertex and pronotum.

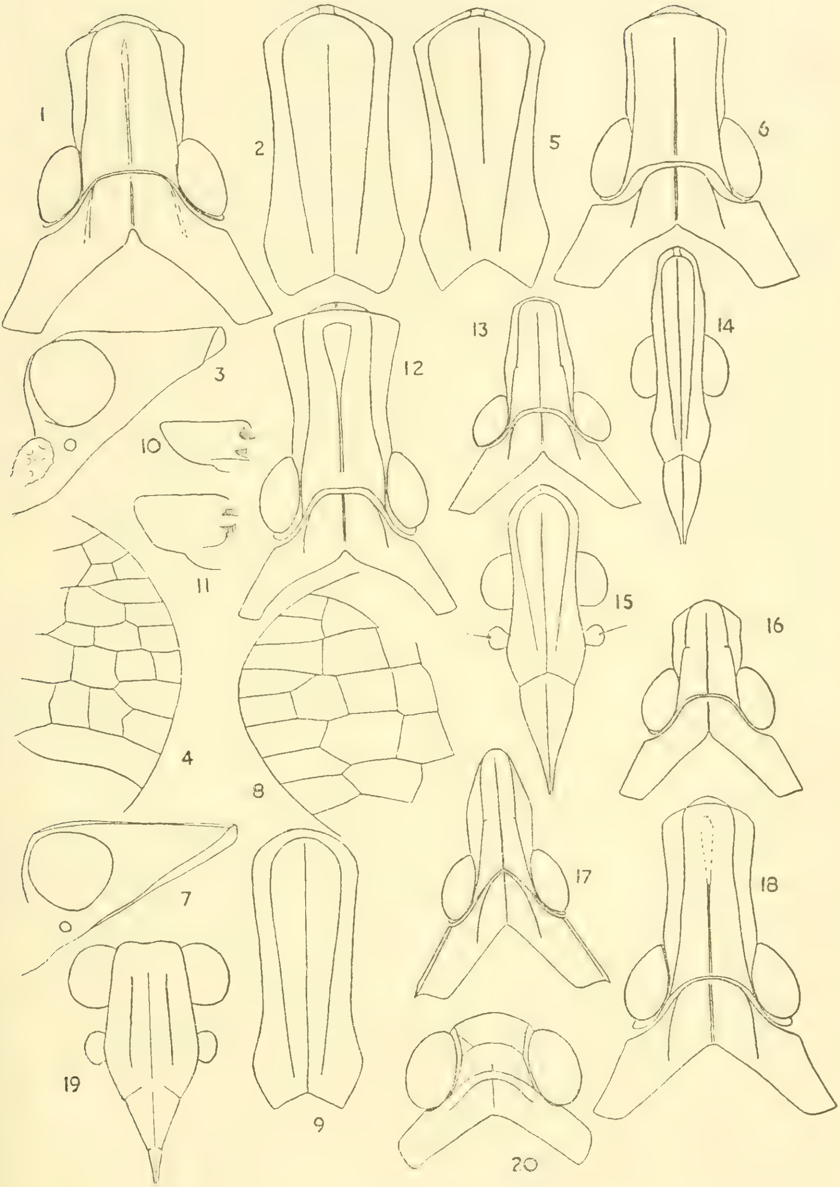
37, 38. *Taosa muliebris* (Walker). 37, vertex and pronotum; 38, frons and clypeus.

39, 40. *Taosa terminalis* (Germar). 39, vertex and pronotum; 40, frons and clypeus.

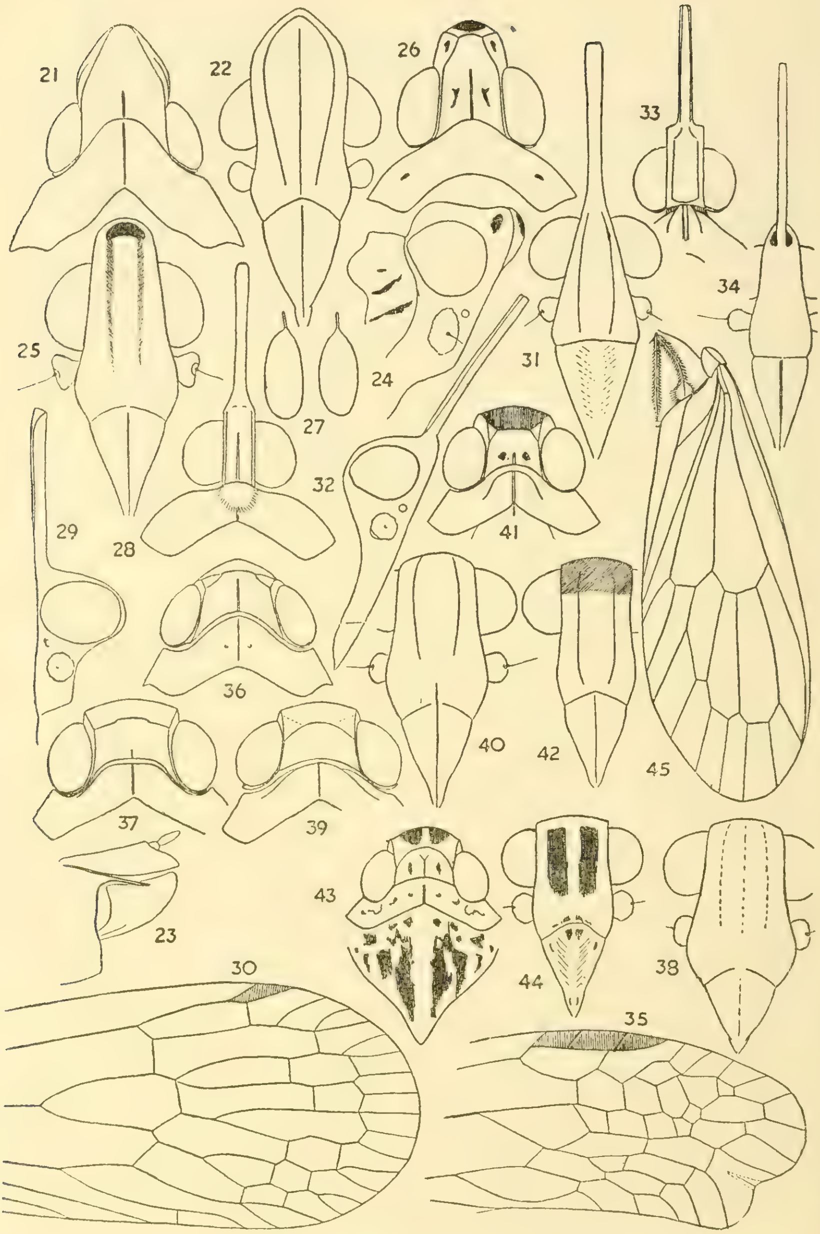
41, 42. *Taosa viridifrons* (Walker). 41, vertex and pronotum; 42, frons and clypeus.

43, 44. *Taosa scriptiventris* (Walker). 43, vertex, pronotum, and mesonotum; 44, frons and clypeus.

45. *Neommatissus congruus* (Walker). Right half of mesonotum and tegmen.



(For explanation, see p. 12.)



(For explanation, see p. 13.)

SMITHSONIAN MISCELLANEOUS COLLECTIONS
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THE WINELAND VOYAGES

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(Publication 3906)

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INTRODUCTION

The narratives of the Wineland (Vinland) voyages occupy, in English translation, only 61 pages in the volume of "Original Narratives of Early American History" dealing with "The Northmen, Columbus, and Cabot," and the actual material on which studies of the voyages themselves and attempts to identify the landing places must be based is of course very much smaller. In the Saga of Eric the Red 6 lines are devoted to Leif's discovery, 10 pages to Karlsefni's voyage. From the Flat Island Book not more than 18 pages are given to all the voyages.[1] On this narrow basis vast structures of theory have been erected and by it an enormous literature has been created. The first appearance of this problem is thus described by Steensby (1918, pp. 18, 19):

Whilst, in the middle ages in the North, it was not doubted that a Wineland existed which had been visited by Icelanders, this information had great difficulty in taking root and maintaining itself in the literary circles of Europe. Even Adam of Bremen found it necessary to state that he had got his knowledge concerning Wineland "not through a fabulous tale, but through reliable accounts from the Danes." It seemed to be a somewhat incredible thought that an island with vines and self-sowing corn should lie on the other side of Greenland with all its ice and cold.

The knowledge of Wineland therefore died out, and the records about it were practically forgotten for several centuries. It was only in the 17th century that the name Wineland was once more drawn into literature, and it was Thermod Torfæus who first, in 1705, through his treatise "Vinlandia," really seriously drew the attention of the literary world to the Norsemen's ancient discovery of America. Finally, in 1837, C. C. Rafn's *Antiquitates Americanae*

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[1] Throughout this paper I have used the Reeves translations of the Norse documents as given in the volume of "Original Narratives of Early American History" devoted to "The Northmen, Columbus, and Cabot, 985-1503," edited by Julius E. Olson, pages 14-66. This is recognized as one of the best. The material covers such a small space that it is considered unnecessary to refer to the particular page that is being quoted.

came out, and gave the literary world a summary of the Icelandic accounts of the Wineland voyages.

Rafn also attempted to identify those points on the North American coast at which the Norse voyagers had touched. From this time on the voyages were mentioned in all works dealing with the history of America or the territories along its northeastern seaboard, and Rafn's conclusions were widely accepted until a critical examination of the sources was undertaken by Gustav Storm, whose work appeared in 1887. Shortly afterward, in 1890, the narratives were made available to English and American scholars in the original and in translation by Arthur M. Reeves, along with the results of Storm's investigations.

There are three principal original documents describing the Wineland voyages, but two of these differ only in details and are regarded as essentially one narrative to which the name of the Saga of Eric the Red has usually been given, although the real hero of the story is Thorfinn Karlsefni, and its heroine his wife Gudrid. The third document is a compilation called usually the Flatey Book or Flat Island Book, the preparation of which dates from a somewhat later period. Storm's researches resulted in establishing to the satisfaction of most scholars the vastly greater reliability of the Saga, thereby reversing the attitude which, following Rafn, had hitherto prevailed. This conclusion was not always accepted, however, and in particular a Danish naval officer, William Hovgaard, in a work entitled "The Voyages of the Norsemen to America" (1915), maintained that the two narratives were of equal value. He was promptly answered by Finnur Jónsson, and Storm and Jónsson have been followed by all the more careful students of the Wineland expeditions. Their attempts to determine what points on the American main were visited by Leif and Karlsefni have been based upon the Saga to the practical exclusion of the story in the Flat Island Book. Storm's conclusions are undoubtedly justified as giving a judicious appraisement of the relative value of the two sources, yet I submit that adverse criticism may be overdone. A hostile critic might work as much havoc with the Saga as others have with the story of the Greenlanders, and in my study of the voyages which follows I have tried to weigh the value of the two sources as justly as possible.

If one of two documents dealing with certain historical events is taken as an infallible guide and everything which diverges from it is rejected, the truth may be obscured although the document chosen is the better of the two. In the present instance I hold that students are right in placing the Saga of Eric the Red in the primary position, but it does not therefore follow that it is invariably correct and the Flat Island Book always in error. Essentially the Saga is the story of Thorfinn Karlsefni and his American expedition; it is based, I feel, on the reports of eyewitnesses on an actual voyage, and I am inclined to give great weight to the statements it contains. It is disappointing, however, in the small space devoted to other expeditions, and I am of the opinion that the Flat Island Book has preserved certain items regarding them which had escaped the writer of the Saga. I do not think that its account of Karlsefni's expedition is merely a garbled version of that contained in the Saga. In the discussion to follow we shall try to see what it seems possible to make out of these narratives by a careful cross-examination and the demands of logic.

Following upon Gustav Storm's work, the wave of enthusiasm for "precursers of Columbus" and for things Scandinavian gave place to a counter wave of skepticism. In 1892 J. P. McLean, in order to confute the claims being put forth that many Atlantic crossings had been made before Columbus and that Columbus had learned of America through the Norsemen, attacked with vigor and success various stories of trans-Atlantic voyages by Irish, Welsh, and others, but pressed his charges also against the claims of the Icelanders and Greenlanders. This is reflected in the writings of the period by less extreme opponents. In the same year B. H. DuBois wrote: "That the Northmen sailed south along the coast of America is not improbable, but it *cannot be proved*." A similar opinion rendered by a committee of the Massachusetts Historical Society (1887) has often been quoted and well exemplifies the attitude toward this question by the scholars of the period (McLean, 1892, p. 39):

> There is the same sort of reason for believing in the existence of Leif Ericson that there is for believing in the existence of Agamemnon—they are both traditions accepted by later writers; but there is no more reason for regarding as true the details related about his discoveries than there is for accepting as historic truth the narratives contained in the Homeric poems. It is antecedently probable that the Northmen discovered America in the early part of the eleventh century; and this discovery is confirmed by the same sort of historical tradition, not strong enough to be called evidence, upon which our belief in many of the accepted facts of history rests.

Skepticism reached its culmination, however, in Fridtjof Nansen's work "In Northern Mists" (1911), which cast doubt upon the historicity of all of the Wineland narratives though Nansen did not deny that the Norsemen had some knowledge of the coasts west and southwest of Davis Strait. However, Nansen has had few followers and in the light of the researches of northern scholars among early documents and archeological investigations of the Norse ruins in Greenland, Leif and Karlsefni can no longer be classed with Agamemnon. That they were historical characters cannot reasonably be doubted, whereas, in spite of the tablets of Boghaz Koi, Agamemnon remains in the domain of legend. The factual basis of the stories of the Norse voyagers is tacitly admitted by later students in devoting their attention almost entirely to studies of the locations which they visited, though depending mainly, almost uniformly in fact, upon the Saga of Eric the Red. Notable among later studies are those of H. P. Steensby, Finnur Jónsson, W. H. Babcock, Juul Dieserud, William Hovgaard, Halldór Hermannsson, and Matthias Thórdarson.

In addition to the above and to a number of scholarly publications besides, there has been an exceptional output of uncritical literature attempting to place Leif and his successors in all possible and impossible places, and to trace certain remains to them, some of it, like the works of Prof. E. N. Horsford, elaborately and expensively clothed. The fact of the matter is that the data are just strong enough to tempt one to theorize and just weak enough to open the door for an immense amount of speculation, especially if one has an undisciplined imagination and a plentiful supply of local pride or wishful thinking. In pursuit of their investigations students have emphasized or questioned almost every statement of the narratives, picked up the slightest hint, attempted to read the minds of the explorers and chroniclers, and frequently to read into their minds things which never occurred to them. Charts of the entire northeastern coast of America have been microscopically examined, the fauna and flora in its present distribution and possible past distribution haled into court, and the precise meaning of this, that, and the other Icelandic word discussed at length. It is one of those investigations which enable men who pride themselves on their acumen to prove it by leaving the problems ostentatiously alone or by registering skepticism, the cheapest way there is to acquire a reputation for scientific ability.

Yet, after all has been said, we may remark that—as with philosophies—while all Wineland theories have been partly wrong, they have not been entirely wrong. And it is but fair to add that some progress has been made and that, although we are not optimistic enough to believe, like Horsford, that we can determine where Leif and Karlsefni came ashore near enough to erect monuments, we can determine areas within which beyond reasonable doubt the landings took place. We must deal with areas instead of points and probabilities instead of absolutes.

I have been attracted to this problem in part by my studies of the Indian tribes of North America, and in part by my experience in attempting to extract the truth out of a number of conflicting narratives dealing with explorations in other parts of the New World. An examination of the two sources leads me to think that we have here a problem somewhat similar to one that I have faced twice before—in French and in Spanish. Beside the well-documented, historical narratives covering early colonial times in Louisiana we have a pseudo-historical work by the engineer Pénicaut, the chronology of which is utterly misleading and the record of events seriously disjointed and often garbled. The chronicles of the De Soto expedition present us with something similar. Here we have three narratives which are very nearly factual in their statements and a fourth which is highly elaborated, verbose, frequently inaccurate as to dates and the sequence of events, and teeming with exaggerations. Yet Pénicaut and Garcilaso de la Vega have preserved certain matters of distinct value to us overlooked by the other chroniclers. As an example I might cite Garcilaso's elaborate accounts of two expeditions sent from the Indian town of Cofitachequi to apprehend a chieftainess of that place. As two of our most reliable authorities ignore these completely, it seemed at first as if the stories of them might be wholly apochryphal. Until, that is, upon turning to the third and briefest narrative, we read that the chieftainess in question left her town suddenly and that De Soto "caused her to be sought." Therefore, when we have a narrative of this type, such as seems to be contained in the Flat Island Book, it is fair to give it careful examination and not to dismiss it cavalierly under a blanket indictment covering the document in which it is contained. As a result of my own examination I conclude that, while the strictures of Storm and his successors, aside from those based on linguistic grounds which I am not equipped to discuss, are in large measure justified, the condemnation has frequently been too sweeping, and on the other hand the Saga of Eric the Red will not stand up much better under the same sort of criticism.

As just intimated, the writer is not conversant with the language in which the Sagas were written or the related tongues, but this side of the question has been so carefully covered by others that it is pretty safe to take one's information second-hand. These preliminaries having been disposed of, let us proceed to a study of the story which the narratives under discussion reveal.

STORY OF THE EXPEDITIONS

In the year 982 Eric the Red was banished from Iceland for a period of 3 years. About 900 (Fischer says 920) a Norwegian named Gunnbiörn on the way from his own country to Iceland had been blown out of his course, and he discovered some islands to the west which were afterward called Gunnbiörn's Rocks (Brunn, 1918, p. 4; Fischer, 1903, p. 6). Eric directed his course thither, reached the coast of Greenland, and rounding its southernmost point, discovered the more habitable parts on the western coast. When the period of his exile was over, he returned to Iceland with such flattering accounts of the new land that intending colonists flocked back with him—in 25 vessels according to some, 35 according to others (Brunn, 1918, p. 28; Fischer, 1903, p. 20; Olson, 1906, p. 16; Babcock, 1913, p. 34). Only 14 actually arrived, the rest having been lost or forced to return, but more soon followed and two main settlements were formed, the East Settlement about the present Julianehaab and the West Settlement, the smaller of the two, in the Godthaab district. Eric himself settled in a fiord now called Tunugdliarfik which took his name and was known as Ericsfiord, at a place called Brattahlid. The next deep inlet to the south, now Igalikofiord, was known as Einarsfiord, and at Gardar on a neck of land between the two came to be located the Episcopal seat of the Bishop of Greenland. In the small fiord now called Amitsuarsuk a prominent man named Heriulf settled, and the inlet was in consequence known as Heriulfsfiord. The point Ikigeit just north of the entrance was called Heriulfsness. These and numerous other points in the two Greenland settlements have been carefully located by Danish scholars (Brunn, 1918, p. 28).

Eric had three sons, Thorstein, Leif, and Thorvald, the last probably illegitimate, and an illegitimate daughter Freydis, married to a man named Thorvard.

In the summer of 999 Leif voyaged to Norway, where he spent the following winter with King Olaf Tryggvason, and on his departure he was commissioned by the king to carry Christianity to Greenland, a charge which he accepted with some misgivings. Substantially the same story is told by the Saga and the Flat Island Book. Of Leif's return voyage to Greenland the latter says nothing, but according to the former it was during this return voyage that he discovered America.

For a long time he was tossed about upon the ocean, and came upon lands of which he had previously had no knowledge. There were self-sown wheat fields and vines growing there. There were also those trees there which are called "mausur," and of all these they took specimens. Some of the timbers were so large that they were used in building.

The above is in the narrative generally relied upon by students of the Norse voyages, who therefore date the discovery of America in the year 1000. But, whether erroneously or not, the Flat Island Book tells of another and earlier landfall and makes that the inspiration for a later voyage to the new land by Leif. Mention has been made of the prominent Greenland settler named Heriulf and of his settlement in Amitsuarsukfiord. So much is beyond dispute. According to the Flat Island Book, however, this Heriulf had a very promising son Biarni who early evinced a taste for voyaging and finally obtained possession of a trading vessel. "It was his custom," goes the tale, "to pass his winters alternatively abroad and with his father," but during the last winter that he spent away, this time at least in Norway, his father accompanied Eric to Greenland.

Biarni arrived with his ship at Eyrar [in Iceland] in the summer of the same year, in the spring of which his father had sailed away. Biarni was much surprised when he heard this news, and would not discharge his cargo. His shipmates inquired of him what he intended to do, and he replied that it was his purpose to keep to his custom, and make his home for the winter with his father; "and I will take the ship to Greenland, if you will bear me company." They all replied that they would abide by his decision. Then said Biarni, "Our voyage must be regarded as foolhardy, seeing that no one of us has ever been in the Greenland sea." Nevertheless they put out to sea when they were equipped for the voyage, and sailed for three days, until the land was hidden by the water, and then the fair wind died out, and north winds arose, and fogs, and they knew not whither they were drifting, and thus it lasted for many "dœgr." Then they saw the sun again, and were able to determine the quarters of the heavens; they hoisted sail, and sailed that "dœgr" through before they saw land.

In brief, they sight three countries in succession before reaching Greenland, and to come upon each new land takes 1 "dœgr" more than the last, 2 to pass from the first to the second, 3 to pass from the second to the third, 4 to pass from the third to Greenland, and finally Biarni comes to land directly in front of his father's house in the last-mentioned country. This narrative has been rejected practically in toto by later writers, and they may be justified in doing so. Although Heriulf is a well-known personage, no son of his named Biarni is otherwise revealed to us. Possibly, as has been suggested, Biarni was a companion of Leif when he voyaged from Norway to Greenland via America, or it may be that the entire tale is but a garbled account of that voyage and Biarni another name for Leif. There is some parallelism it must be admitted. Biarni is tossed about on the ocean in traveling from Iceland to Greenland much as Leif was in going from Norway to the same place. A little later the Flat Island Book tells us that Biarni, like Leif, went to Norway, became acquainted with the then king, Earl Eric, related his travels to that monarch, "was appointed one of the Earl's men, and went out to Greenland the following summer." And finally Biarni's father and Leif's father were near neighbors and lived in adjoining fiords. Although Leif spent more time in America than Biarni, both seem to have been anxious to get home to their parents. The three lands which Biarni saw are uniformly identified with the three that Leif and Thorfinn Karlsefni saw according to the Flat Island Book, which, as we shall see presently, drops one stopping place of Karlsefni out of the picture.

It has also been suggested that Biarni Heriulfson may have derived his existence from the story of Biarni Grimolfsson, who appears in the Saga as a fellow merchant of Karlsefni, like the other Biarni voyaged to Greenland from Iceland, and like him was caught in a storm at sea a little later.

Naturally enough the arithmetical progression by which Biarni Heriulfson reached the several lands he encountered is held up against the historicity of the narrative, as is the reported accuracy with which he ultimately found his father's home, one he had never seen. The "foolhardy" venturesomeness of the expedition into an unknown sea is also urged against it just as Biarni himself is said to have anticipated.

It is only fair, however, to enter some counterarguments. For instance, the stories of Leif's visit to King Olaf and Biarni's to that king's successor are in the same narrative in the Flat Island Book where there is less likelihood of duplication than if they were from different sources. Norse captains voyaged back and forth frequently between Norway, Iceland, and Greenland, and there is no reason why several voyages should not be recorded. Biarni visited three lands on his way to Greenland and landed on none of them. Leif apparently visited but one and he actually landed upon that, bringing back with him specimens of the self-sown wheat, vines, and timber. Heriulf, as well as Eric, was a prominent man, and there is no reason why he should not have had a noteworthy son. The fact that he and Eric lived in neighboring fiords is of minor consequence in its bearings on the movements of their offspring. The resemblance between Biarni Heriulfson and Biarni Grimolfsson is superficial. Both voyaged to Greenland from Iceland, but so did almost all the Greenland colonists. Both went to America, but under very different conditions, the one driven by accident, the other as a companion of Karlsefni on a purposeful voyage. Both were caught in a storm on the ocean, but the experience was too common to have any significance, and while Heriulfson seems to have made his home in Greenland and died peacefully there, Grimolfsson was drowned at sea.

Again, it does not follow, as has been assumed, that the first of the three lands seen by Biarni was identical with Wineland. The third land he came upon before reaching Greenland is known to have been Helluland, for it is distinctly stated, and the identity of the second with Markland, although not stated, is to be inferred rather clearly, but the connection of the first with Wineland is by no means evident. It was "level, and covered with woods," and "there were small hillocks upon it." Only by the "hillocks" does it differ from the description of Markland. What is said later on regarding Wineland by the writers of both narratives does not emphasize the forests particularly, though they are often noted incidentally, and the only approach to a mention of "hillocks" is in the Saga, where it says "wherever there was hilly ground, there were vines." This is a rather slender thread to hang an identification upon. The two wooded lands might have been Newfoundland and southern Labrador or Newfoundland and Nova Scotia.

Another point may be added in connection with Helluland. If the two narratives were taken from the same source, we should expect a closer resemblance between the descriptions of that country. The Saga says of it: "They . . . . found there large flat stones (*hellur*) and many of these were twelve ells wide." According to the Biarni narrative, however, "this land was high and mountainous, with ice-mountains upon it," and later, in describing Leif's supposed visit to the same country, the Flat Island Book says they "saw no grass there; great ice mountains lay inland back from the sea, and it was as a (tableland) of flat rock all the way from the sea to the ice mountains." One further point may be significant. When Biarni and his fellow voyagers turned their prow away from Helluland and filled away for Greenland, the chronicler says that they "saw that it was an island." This is an incident of which there was no particular need in a made-up narrative, and it is improbable that this island has any connection with the Biarney Island or Islands that Karlsefni sailed past when he crossed from Greenland to Helluland.

The intervals of 1, 2, 3, and 4 "dœgr" in making the passages from land to land is admittedly highly suspicious, but so is the use of 2 "dœgr" two or three times in succession in the Saga of Eric the Red.

Mythic formulas of this kind may be introduced into narratives without altogether destroying their historicity.

The Biarni narrative has been condemned for very opposite reasons—because of Biarni's alleged attempt to reach Greenland which neither he nor any of his men had seen, and because of the assertion that he was driven so far out of his course. It will be noticed that he himself anticipated the first criticism. But Greenland is only about 200 miles from Iceland, and the direction in which it lay was well known. Biarni's venture seems to me no more foolhardy than that of Thorstein Ericsson, who set out to cross Davis Strait to a land visited but once before by any Norseman, or that of Thorhall in sailing for Greenland from Streamfirth with a crew of nine men, or more particularly the voyages of Leif from Greenland to Norway and return, but of those more presently. As to the second, it should be recalled that when Greenland was settled, of 25 or 35 vessels setting out from Iceland only 14 arrived in spite of the fact that they were guided by Eric. Also that Thorbiorn and his friends in attempting the same passage experienced "great gales," "lost their way," and did not arrive until "the very eve of winter." Thorstein's failure to reach his objective, which some of his men had visited, was much more monumental than that of Biarni to arrive at once in Greenland, where no one on his ship had been. Yet these adventures are all described in the supposedly authentic Saga of Eric the Red. As to the distances to which Thorstein and Biarni were driven, there is not much to choose between them if Biarni actually reached the New England coast, which there is reason to doubt, and Thorstein, who knew presumably where he was going, deserves more blame for his failure than Biarni who merely had the general direction. However, as we have already seen, it is not necessary to imagine that Biarni went so far. If Biarni's voyage is "incredible," Thorstein's is still more so.

It is also held up against the Biarni narrative that its hero is made to come upon the coast of Greenland exactly in front of his father's home which neither he nor any of his crew had visited. This may very well be an item in the build-up of his hero by the compiler of the tale. Still, accidents of the kind have happened, and it may be mentioned as a possible explanation that Heriulfsness lay "below" two high mountains called Hvidserk and Hvarf, the latter a landmark for vessels voyaging between Greenland and Iceland or Greenland and Norway, and that near it was a harbor called Sand "which was a universal harbor for Norwegians and merchants." There is still less reason for criticizing the Flat Island Book because it represents later voyagers to Wineland as having reached without difficulty the cabins Leif had erected there. If one is to be literalistic he might cavil at the Saga for saying that "Leif landed in Ericsfirth" on his return from Wineland as too specific, and that is the only landfall given for Thorstein after he had tossed about on the ocean all summer. Nor does Karlsefni seem to have had any difficulty in reentering Streamfirth on his return from Wineland. Must one supply complete logbooks of all the Norse voyages?

Equally unreasonable is the attack on the Flat Island Book chronicle because it says that Biarni settled in Greenland and "gave up his voyaging," yet proceeds immediately afterward to relate a visit he made to the court of the King of Norway. The sentence on which this criticism is based runs as follows: "Biarni now went to his father, gave up his voyaging, and remained with his father while Heriulf lived, and continued to live there after his father." Now, the "voyaging" that he gave up was plainly his annual trading expeditions, and it is not said that he "continued to live" at Heriulfsness until his death. He made his home there, but the wording does not exclude visits to other countries.

My experience with narratives of this kind has taught me that, while corruptions and confusions are common, absolute fictions are rare and usually of a kind to be identified with comparative ease. I am inclined to think, therefore, that there is something other than pure fiction behind this story of Biarni. Iceland lay nearer the American main than Norway, and if we can believe that Leif came to America from Norway across the entire breadth of the North Atlantic, its discovery by a voyager from Iceland does not seem incredible. We may well doubt the time scale assigned to him and the accuracy of his Greenland landfall, as reported, and marvel at his seeming want of curiosity regarding the lands he observed, but we must not expect too much of chroniclers of the fourteenth and fifteenth centuries, and on the last point recollect that the summer was far advanced and voyaging on the northern seas in winter greatly dreaded.

I would give up Biarni more readily were it not that the story of Leif's voyage contained in the supposedly more reliable Saga of Eric the Red is almost as amazing, in some ways even more so. If Biarni was blown out of his way as far as the New England coast, he covered about 2,400 statute miles, but it is not necessary to suppose that he got farther than Newfoundland, a voyage of about 1,600 miles, whereas Leif apparently crossed the full breadth of the North Atlantic nonstop, and even if we suppose he did not get farther than Nova Scotia, that means a voyage of about 3,000 miles out of sight of land, close to Columbus' record, and what a difference in the size of vessels and in the weather! As sometimes charted, this would have been against the flow of the Gulf Stream and in the teeth of the prevailing winds. To make his voyage at all credible we must suppose that he kept well to the north, taking advantage of the counter current past Iceland and around the southern point of Greenland and the easterly winds in that latitude, and was caught by a north wind off Greenland. From Iceland on, this is the course that must be assumed for Biarni. The sailing directions from Norway to Greenland are thus given by Brunn (1918, legend, pl. 6):

> Leaving Hernum (islands near Bergen) going towards the west to Hvarf in Greenland [identified by him with Nunarssuit (Cape Desolation)] . . . . ; as one goes north round Hjatland ([S]Hetland), one could just see the land, thereafter south round the Fâeroe islands, so that one saw half the height of the mountains, to the south round Iceland, so that the sea birds and whales could be seen (in one place the distance is given as 48 miles), after which one came to the high land in Greenland, which is called Hvarf. The day before, another high mountain is seen, which is called Hvidserk (in the vicinity of Greenland's southernmost point), and below (between?) these two mountains - - - Heriolfsness lies, and near to it is a harbour, which is called Sand, which was a universal harbour for Norwegians and merchants.

The sailing directions from Iceland to the Eastern Settlement of Greenland, indicating the course which Biarni should have taken, were as follows (ibid.):

> a) The ancient course: From Snæfellsness, two days and two nights sailing straight to the west to Gunbiørns skerries, midway between Greenland and Iceland (i.e., one had traversed half the way to the eastern settlement. Gunbiørns skerries most likely lay in the present Angmagssalik on Greenland's east coast beneath 66° n. lat.). b) The later course, after ice having come "out of the sea bays" so near to the skerries, that no one could sail the ancient direction without danger of life: From Snæfellsness straight to the west for one day and one night, just slightly to south west so as to escape the above mentioned ice, which lies near Gunbiørns skerries, and then on for one day and one night to the north west, then one comes under Hvarf. From Snæfellsness, the shortest way to Greenland is "four days sailing" (Landnáma).

If we accept the story of Leif's voyage as given in the Saga, we must suppose that he was carried along this northern route, without seeing Iceland or Greenland apparently, and was then caught in a north wind and carried to America. An amazing trip at that. Biarni's adventure is less incredible, especially if we assume that he was not carried farther south than Newfoundland, and when we compare the two, we are led to the suspicion that the story of Leif's voyage in the

Saga leaves something out, and that the discovery was actually due to an independent voyage inspired by Biarni's accidental discovery. In either case we may still regard Leif as the discoverer of Wineland. I think, too, that the writer of the narrative in the Flat Island Book has confused the stories of Leif's and Karlsefni's visits to Wineland.

These points are raised, not to destroy faith in the Saga as our most reliable source of information regarding the Wineland voyages, but in order to light up a tendency to allow a belief, however well founded, to become a dogma and warp one's critical faculty. Thus Leif's voyage across the entire width of the North Atlantic is said to be "probable" because incorporated into the narrative of a preferred authority, while Biarni's is "improbable" or even "impossible" because the document containing it has been condemned.

But why did not the Greenlanders take more interest in Biarni's discoveries until Leif's return from Norway 14 years later? However, one might have asked, Why did not the Icelanders take more interest in Gunnbiörn's Rocks until more than 60 years had passed? Probably for the same reason. When Gunnbiörn made his discovery, Iceland had not been completely occupied and the population had not begun to press upon the available supply of land. When Biarni discovered America—if he did—all that he observed of the country was that toward the south it was wooded and the wooded land lay at a distance with a region of desolation (Helluland) in between. Greenland was just being settled, the good sites were not all taken up, and the more readily available supplies of wood had not been exhausted.

But, according to the Saga, this lack of enterprise was shared in even greater degree by Leif, for after having landed in Wineland, and having obtained samples of "self-sown wheat," vines, and "mausur" wood, he returned with them to Greenland without displaying the least personal ambition to visit that land of riches again. Thus, in six lines, the Saga tells us that Leif made one of the greatest discoveries of all time, and noted and sampled the principal riches of the country as described by all later visitors. On his way back he rescued some people from a wreck, took them home with him, and procured quarters for them during the winter. "In this wise," the narrative proceeds, "he showed his nobleness and goodness, since he introduced Christianity into the country, and saved the men from the wreck; and he was called Leif the Lucky ever after"—"Lucky," not because he discovered a continent more than four times as big as Europe, but because he rescued some men at sea and introduced a new religion into Greenland. Here is a man, if we are to trust the Saga, with a soul above skittles, and, more remarkable still, he is the son of that same man who brought about a mass migration to the second largest block of ice in the world by naming it Greenland. How the old man must have fumed at this degenerate son of his who spent his time caring for shipwrecked mariners and spreading the gospel of a spiritual world instead of becoming the father of a great material one! That helps to explain Eric's stubborn adherence to paganism. He belonged to the Order of the Main Chance. If the Saga is correct, Leif did not even take enough interest in his Land of Wine to visit it a second time. Except for his affair with the woman Thorgunna in the Hebrides, he would deserve sainthood and, as one who preferred "Greenland's icy mountains" to the fertile empire of Yankeedom, he would naturally become Greenland's patron saint. As things are, he should stand second only to Eric in the affections of Greenlanders and have his own monument in Ericsdall.

However, when we remember that Biarni Heriulfson would not even land in America because he was anxious to get home to his father, we have to admit that these rugged Northmen had virtues to put us to shame. We have credited them overmuch with a lust for rapine and skull cracking, but here are two glittering exceptions, a man who to the riches of America prefers rescuing mariners and preaching religion, and another who turns all mainland America down in favor of his father.

Speaking more seriously, however, does not this visit of Leif to Wineland after a nonstop passage of the entire North Atlantic, cavalier dismissal of the whole experience, and subsequent utter indifference, seem a bit fishy even when told by our "most reliable" authority? Or does it mean that Karlsefni had the better press agent? Upon the whole does it not seem rather probable that Leif should have made an extended visit to Wineland, whether from the suggestion of a previous explorer or an earlier chance landfall by himself?

We will consider Leif's supposed expedition from Greenland later, but there is one item which apparently must be assigned to it or else to his landfall in a voyage from Norway as the Saga has it. That is the story of the discovery of grapes, of which we have two versions. The one contained in the Saga places the event at Streamfirth considerably north of the true Wineland and gives it as an event in the voyage of Karlsefni, but it has long been recognized that this is an interpolation and it is almost universally held that Streamfirth was well north of the land of grapes. According to this story the discovery was made by two Gaels named Haki and Hækia who were very fleet of foot and had been presented to Leif by King Olaf and by him loaned to Karlsefni. These two were set on land at a point near the mouth of Streamfirth and told to run south to view the country and return before the end of the third half-day. When they came back, one had a bunch of grapes and the other an ear of new-sown wheat.

According to the Flat Island Book grapes were discovered during Leif's stay in Wineland when he reached that country from Greenland, and by a German named Tyrker who had long been in Eric's family and was regarded by Leif as a foster father. The narrative states that on arriving in Wineland, the Norsemen put up a substantial house, and after that Leif began a systematic exploration, half of his people going out to examine the country each day and half remaining at home, the parties alternating in exploration and housekeeping. The explorers were directed not to go beyond points from which they could return the same day. One evening Tyrker was missing but when search was made he soon appeared in a highly excited state of mind reporting the discovery of grapes. Forthwith Leif directed his people to begin loading their vessel with vines, grapes, and wood for the return journey "and when spring came they sailed away."

The very name given to this country shows that to the adventurers the most striking thing about it was the presence of grapes, and that is why these two stories have been preserved—or concocted. Except for the use subsequently made of this fruit, there is not much to choose between the two narratives on the ground of credibility. It is possible that there is a connection between the names of Hækia (of which Haki seems to be a synonym) and Tyrker, but the two Gaelic runners suggest to me more that they may be products of mythic lore than does the appearance of a German. I am not informed as to the status of grapes in Scotland or Ireland and the early use of wine there, but the story of the German appears the more probable. Hermannsson (1936, p. 38) unjustifiably interprets this man's excitement as due to intoxication. The narrative suggests only elation at his find and the possibilities it involved. The point in this narrative about which one may well feel skeptical is the preservation of a load of grapes all winter and their transportation in usable shape to Greenland, unless, that is, we suppose them to have been carefully dried. The Saga merely says that Leif took specimens of the vines he found in Wineland without indicating whether there were grapes attached and if so in what shape they reached their destination. It notes the fact that Karlsefni found vines in Wineland but says not a word of any use to which their fruit was put by him. According to the Flat Island Book, however, quantities were brought back by every explorer. Here apparently the reputation of the country has overbalanced the chronicler's judgment. At the same time he should be cleared of a false accusation to the effect that he describes grape gathering as taking place in the spring. The translation runs: "A cargo sufficient for the ship was cut, and when the spring came, they made their ship ready, and sailed away."

If there is any truth in either of the stories of how grapes were found as above given, they belong to Leif's explorations and not to Karlsefni's. The attempt to find in Tyrker a distorted version of Thorhall the Huntsman appears to me far-fetched. Except that both are said to have lived with Eric, I find no resemblance between them whatever.

On his way back from Wineland to Greenland, according to both of our narratives, Leif rescued some people who had been shipwrecked and brought them to Greenland to spend the winter with him. The Saga places this event, of course, at the end of his voyage from Norway, but the other during his return from a special voyage to Wineland. The Flat Island Book has confounded the voyage of Thorbiorn and his daughter Gudrid from Iceland to Greenland with the story of this wreck, probably because the hospitality of Eric was extended to both parties involved and they arrived about the same time. Holand (1940, p. 29) has supplied a satisfactory explanation of the confusion by calling attention to the fact that another Gudrid, "the daughter of one Ingjald in Iceland, went to Norway where she married and about this time came to Greenland."

According to the Flat Island Book, Leif's brother Thorvald voyaged to Wineland after Leif returned, but the next expedition detailed by the Saga was led by another brother, Thorstein, who is highly praised. The explorers urged Eric to accompany them believing that it would bring them luck, and though the old man demurred, he finally consented. Before setting out he carefully hid a little chest containing gold and silver, but on his way to the vessel the horse on which he was riding threw him, "broke his ribs and dislocated his shoulder," and he attributed this accident to the fact that he had hidden his treasure and therefore he sent word to his wife to go and get it. He was not, however, deterred from accompanying the explorers, but they had a very stormy voyage and were driven in sight of Iceland "and likewise saw birds from the Irish coast." "In the autumn they turned back, worn out by toil, and exposure to the elements, and exhausted by their labors, and arrived at Ericsfirth at the very beginning of winter." All those not otherwise provided for were cared for at Brattahlid during that winter.

The Flat Island Book describes this attempted visit to Wineland in much the same language but with certain important changes. The effort to have Eric as a companion is placed not at the beginning of this trip but before that of Leif already mentioned. As in the other narrative, Eric finally consents and rides to the boat and, as in that, he is thrown from his horse. However, it is his foot which is hurt, nothing is said of any concealed treasure, and he gives up and returns home. Thorstein's object in making the voyage, according to the same document, was to bring home the body of his brother Thorvald. This desire loses some of the "strangeness" which has been charged against it when we remember how insistent Thorstein himself was, after his own death, that his body and the bodies of his companions with one exception be removed from Lysufirth for burial in consecrated ground. It comes out prominently in both sagas. According to the Flat Island Book, Thorstein marries Gudrid before putting to sea and takes her with him, whereas, according to the Saga, he did not marry her until after his return. Again, instead of returning to Ericsfirth and moving afterward to Lysufirth for the winter, the Flat Island Book takes him directly to Lysufirth. In these particulars it is probable that the Saga is more nearly correct.

In reporting the attempt to take Eric along, on the other hand, the narrative given in the Flat Island Book seems more probable and I therefore follow it and assume that it belongs to the expedition of Leif. The Saga reports that on the morning of his departure Eric concealed his gold and silver, and the reason for this is not apparent since his wife remained at home and his house was presumably occupied by responsible persons during his absence. It may have been because his wife had offended him, but I do not understand that gold and silver figured much in Greenland trade at that period. What the farmers did not raise themselves they got by barter. Nor is it likely that Eric's wife would abscond from the best farm in Greenland, there being no place to abscond to within any reasonable distance and no ready means of transportation. But the incredible part of the story is the assertion that, after being thrown from his horse and having some ribs broken and a shoulder dislocated, Eric was not deterred from venturing out upon the boisterous waves of the North Atlantic. If so, he was a remarkably tough specimen. No doubt the Norse had a rough and ready method of treating dislocated shoulders, but one wonders what they did about the broken ribs, and if Eric partook of those "high spirits" with which, as the chronicler assures us, they all set out. According to the Flat Island Book, however, in falling from his horse Eric merely wounded his foot and yet he gave up his intention to go to sea and returned home.

The two narratives are in substantial agreement as to the size of the crew which Thorstein had and their trials.

Thorstein and Gudrid spent the next winter at Lysufirth and the remarkable events which took place there are detailed at length by both of our chroniclers. As just stated, they differ as to the time when Thorstein and Gudrid were married and the time when they went to Lysufirth. The Saga states that they removed because Thorstein owned an estate there jointly with another Thorstein called Thorstein the Swarthy. According to the Flat Island Book they landed at Lysufirth and were unable to find lodgings for the winter until the other Thorstein took them in. The narratives agree, however, in saying that Thorstein Ericsson and the wife of Thorstein the Swarthy died that winter, that the corpses of both came to life afterward, and that Thorstein Ericsson then informed Gudrid that she was to marry an Icelander and have illustrious progeny. However, they differ in enough details to show that we have separate streams of tradition. According to the Saga, Thorstein the Swarthy's wife was named Sigrid; according to the other document it was Grimhild. The Saga alone tells us that she saw the spirits of her dead companions and of herself as a prelude to her own death, and that the principal among them was the overseer of the estate, Gard, who was responsible for the various apparitions. In consequence Thorstein instructs his wife that Gard's body is to be burned but that the others must be taken to Ericsfirth to be buried in consecrated ground. In the Flat Island Book Thorstein is made to foretell to his wife not merely her marriage to an Icelander but a later pilgrimage to "the South," that is, to Rome, and that she will finally take the veil. Both agree as to the final disposition of the bodies and also in stating that Gudrid went to live at Brattahlid, though the Saga informs us that she stayed with Eric, while the Flat Island Book says Leif, having previously entered a note to the effect that Eric was dead. In this last item the Saga appears to have been correct.

At this point Thorfinn Karlsefni, the central figure of the Saga and the most important one in the Flat Island Book, comes upon the scene from Iceland. His ancestry is given with considerable care by both chroniclers. It seems that he was a successful trader, and one summer, the summer of 1002 apparently, he equipped his ship for a voyage to Greenland accompanied by a man named Snorri, Thorbriand's son, of Alptafirth. In a second vessel having the same destination sailed Biarni, Grimolf's son, a man from Breidafirth, and Thorhall, an East-firth man. They landed in Ericsfirth, drove a brisk trade that autumn and, at Eric's invitation, spent the winter with him. During that winter Gudrid and Karlesfni were married. Regarding these events the two narratives are in accord.

"About this time," runs the Saga, "there began to be much talk at Brattahlid, to the effect that Wineland the Good should be explored, for, it was said, that country must be possessed of many good qualities." Karlsefni and the other commanders of the two Icelandic vessels agreed to go thither, and a third vessel was added, manned by Greenlanders from Ericsfirth, among whom were Eric's son Thorvald, his daughter Freydis, her husband Thorvard, and a man named Thorvall the Huntsman who "had been for a long time with Eric as his hunter and fisherman during the summer, and as his steward during the winter." "He was a poor Christian," the Saga continues, but "had a wide knowledge of the unsettled regions," which would be those along the northwest Greenland coast. They sailed in the ship Thorbiorn had brought out, according to the same authority, and 160 men went along, besides cattle. Although the Flat Island Book mentions only one vessel in which went 60 men and 5 women, it adds, "they took with them all kinds of cattle, as it was their intention to settle the country, if they could." One wonders how many kinds of cattle could be accommodated in one vessel besides the 65 human beings.

When Karlsefni and his companions set out upon this voyage—

they sailed to the Western Settlement, and thence to Bear Island (or the Bear Islands). From that point they bore away to the southward for two dœgr. Then they saw land and launched a boat, and explored the land, and found there large flat stones (*hellur*), and many of these were twelve ells wide; there were many Arctic foxes there. They gave a name to the country, and called it Helluland (the land of flat stones).

The several landfalls of Karlsefni between Greenland and Wineland are not mentioned in the Flat Island Book, having already been described in the accounts it gives of the supposed voyages of Biarni from south to north and Leif from north to south. Neither of these is said to have touched the Western Settlement, and there is no note of Bear Island unless it could be identical with the Helluland Island in the account of Biarni's expedition. The descriptions of Helluland in the Saga and in the Flat Island Book have been compared already.

The Saga story of Karlsefni's voyage now continues as follows:

Then they sailed with northerly winds two "dœgr," and land then lay before them, and upon it was a great wood and many wild beasts; an island lay off to the southeast, and there they found a bear, and they called this Biarney (Bear Island), while the land where the wood was they called Markland (Forest-land).

Biarni found the second land to which he came "flat and wooded," and the chronicler evidently intends to identify with it the second land he reports to have been discovered by Leif, which the latter named Markland. Leif, according to this writer, found it to be "a level wooded land, and there were broad stretches of white sand where they went, and the land was level by the sea." The narratives thus agree as to the woods, but the Saga does not add that the land was level. On the other hand it notes the offshore island to the southeast which they called Bear Island. Islands so named seem to have been very common, since, besides the two of this narrative, Graah tells us that the name was applied to Disko. It is evident that our chroniclers did not collaborate in their descriptions of Markland, since they agree in only one feature and that closely associated with the name by which that region came to be widely known.

The two versions of the Saga differ somewhat in their accounts of the next landfall. One says:

Thence they sailed southward along the land for a long time, and came to a cape; the land lay upon the starboard; there were long strands and sandy banks there. They rowed to the land and found upon the cape there the keel of a ship, and they called it there Kiarlarnes (Keelness); they also called the strands Furdustrandir (Wonder-strands), because they were so long to sail by.

The other runs as follows:

When two dœgr had elapsed, they descried land, and they sailed off this land; there was a cape to which they came. They beat into the wind along this coast, having the land on the starboard side. This was a bleak coast, with long and sandy shores. They went ashore in boats, and found the keel of a ship, so they called it Keelness there; they likewise gave a name to the strands and called them Wonder-strands, because they were so long to sail by.

The first version seems to regard Keelness and the Wonder-strands as attached to Markland, while the second implies that it was separated by another stretch of sea. There is no mention of these Wonder-strands in the Biarni narrative, but it is possible that the "broad stretches of white sand" connected with Markland in the Flat Island Book story of Leif's voyage may refer to them if the first version of the Saga quoted above is correct. There is no mention of Keelness here, but it is touched upon in this chronicler's account of the supposed earlier expedition of Thorvald. We shall mention this again but will insert here what concerns the naming of that cape. According to this narrative, then, the second summer Thorvald spent in Wineland he—

set out toward the east with the ship, and along the northern coast. They were met by a high wind off a certain promontary, and were driven ashore there, and damaged the keel of their ship, and were compelled to remain there for a long time and repair the injury to their vessel. Then said Thorvald to his companions: "I propose that we raise the keel upon this cape, and call it Keelness." And so they did.

To the eastward of this cape was a firth into which they afterward sailed, and there Thorvald met his death.

The Flat Island Book says that after leaving Markland, Leif and his companions sailed for 2 dœgr and came to an island on which was dew as sweet as honey. The "2 dœgr" and the crossing might be lined up with the firth to the east of Keelness in the second version of the Saga and so made to support it, just as the white sands of Markland may be quoted in support of the first, but nothing is said in this place of Keelness, and the island is more likely to reflect a memory of the Stream Isle to be mentioned presently. I am inclined to accept the first Saga version which is usually regarded as the more reliable, and the two may be reconciled by assuming that the landfalls were upon the same coast 2 dœgr apart.

The origin of the name Keelness raises an interesting question, and here again it seems to me that the account given in the Flat Island Book is the more probable. Evidently the keel is supposed to have belonged to a European vessel, and the likelihood of such an article drifting ashore from any European settlement is in the highest degree unlikely. The ocean current on the west side of Baffin Bay runs south, and if a keel drifted in from the Greenland settlements we must suppose it was carried northwest by that branch of the Gulf Stream which washes the west coast of Greenland and then south by the Labrador Current for over a thousand miles, and that all this took place between 985 or 986, when Greenland was settled, and the date of Karlsefni's voyage, about 1003—rapid work to have been accomplished within less than 20 years. It would seem that the same Labrador Current must have inhibited pretty effectively the appearance of a keel from Iceland, not settled until 874-930, or any region more remote. If the keel was left by an earlier Norse expedition, and the Saga is solely to be relied upon, it must have been that of Leif, in which case Karlsefni and his companions should have learned of it either then or later. This might be used as an argument that the voyage attributed to Thorvald actually took place, or that the naming of the cape belongs to a later time, that is, to Karlsefni's exploratory voyage to the north during which Thorvald was killed. The first supposition would, however, be open to the objection raised in the case of Leif. Unless, indeed, there is some truth in the account given in the Flat Island Book, I am disposed to believe that this cape was named for some other reason than that given in the Saga, perhaps from its appearance or from some natural feature nearby.

The Saga now continues as follows: "Then the country became indented with bays, and they steered their ships into a bay," and here is inserted the account of the two Gaels, Haki and Hækia, how on being sent southward to explore the country they brought back samples of self-sown wheat and grapes. It has been pointed out frequently that this is an interpolation, and it is clearly shown to be the case by the repetition contained in the last sentence, for it tells us that the Gaels were taken on board again "whereupon Karlsefni and his followers held on their way, until they came to where the coast was indented with bays. They stood into a bay with their ships."

To resume:

There was an island out at the mouth of the bay, about which there were strong currents, wherefore they called it Straumey (Stream Isle). There were so many birds there, that it was scarcely possible to step between the eggs. They sailed through the firth, and called it Straumfiord (Streamfirth), and carried their cargoes ashore from the ships, and established themselves there. They had brought with them all kinds of livestock. It was a fine country there. There were mountains thereabouts. They occupied themselves exclusively with the exploration of the country. They remained there during the winter, and they had taken no thought for this during the summer. The fishing began to fail, and they began to fall short of food. Then Thorhall the Huntsman disappeared. They had already prayed to God for food, but it did not come as promptly as their necessities seemed to demand. They searched for Thorhall for three half-days and found him on a projecting crag.

Being still a heathen, Thorhall is calling upon Thor for help, and a whale presently appears which they "capture." When they ate of it, however, they became sick and, learning of its supposed origin, they threw it into the sea, and again appealed to God, whereupon "the weather improved, and they could now row out to fish, and thenceforth they had no lack of provisions, for they could hunt game on the land, gather eggs on the island, and catch fish from the sea."

In the Flat Island Book the narrative covering this part of the route is very greatly condensed and is incorporated with the Wineland visit so closely that it is not at first easy to separate them. Nevertheless, it is evident that—treated as an expedition under command of Leif—it is covered in the following sentences:

> They . . . . came to an island which lay to the northward off the land. There they went ashore and looked about them, the weather being fine, and they observed that there was dew upon the grass, and it so happened that they touched the dew with their hands, and touched their hands to their mouths, and it seemed to them that they had never before tasted anything so sweet as this. They went aboard their ship again and sailed into a certain sound, which lay between the island and a cape, which jutted out from the land on the north, and they stood in westering past the cape.

Instead of a story of supernatural food-charming we have one of honeydew grass, drawn presumably from the wonder stories of the period, but the geography corresponds. It does not correspond when transferred to Wineland to which the Flat Island Book immediately hitches it. Resuming the narrative as told in the Saga, we find that Thorhall decided to leave his companions at this time, and, taking nine men, all who would go with him, he sailed "northward beyond Wonder-strands," and past Keelness, but was driven to Ireland by westerly gales. There all were enslaved, and merchants reported that Thorhall lost his life.

This narrative presents us with two difficulties. We are told that Thorhall was going "in search of Wineland," and yet in a ditty he is said to have composed he expresses an intention to return home. Another difficulty is the identity of this Thorhall. He is called, not here but at a later point in the narrative, Thorhall the Huntsman. But there was another Thorhall, Gamli's son, an East-firth man, who had come from Iceland as co-commander with Biarni, Grimolf's son, on the vessel which accompanied that of Karlsefni. Nothing more is heard of him, though Biarni is mentioned several times and his fate by drowning at sea carefully recorded. Thorhall the Huntsman went to Streamfirth in the same ship as Eric's son Thorvald, Eric's daughter Freydis, and Thorvard, the latter's husband. Only three vessels are enumerated, but which of these was taken by Thorhall and which Thorhall took it? From what we know of the redoubtable character of Freydis it would seem unlikely that anyone would desert lightly with her vessel, and Biarni, in subsequent parts of the Saga, appears still in command of a vessel, the same in which he was ultimately lost. Again, on the face of it, it does not seem probable that a body of 160 men, more than 50 to the vessel, would have allowed one ship to be carried away to suit the whim of 10. Nor does it seem likely that a vessel capable of crossing the Atlantic was built at Streamfirth. I think we must either suppose there were more than three vessels or entertain doubt of this part of the narrative.

We now come to the last stage of the voyage, from Streamfirth to Wineland. The Saga, which distinguishes plainly between these two regions, says that after Thorhall's departure northward, Karlsefni—

cruised southward off the coast, with Snorri and Biarni, and their people. They sailed for a long time, and until they came at last to a river, which flowed down from the land into a lake, and so into the sea. There were great bars at the mouth of the river, so that it could only be entered at the height of the flood-tide. Karlsefni and his men sailed into the mouth of the river, and called it there Hop [a small land-locked bay]. They found self-sown wheat-fields on the land there, wherever there were hollows, and wherever there was hilly ground, there were vines. Every brook there was full of fish. They dug pits, on the shore where the tide rose highest, and when the tide fell, there were halibut in the pits. There were great numbers of wild animals of all kinds in the woods. They remained there half a month and enjoyed themselves, and kept no watch. They had their live stock with them.

In other words it was a kind of Garden of Eden to these inhabitants of the inhospitable north. The Saga continues:

Karlsefni and his followers had built their huts above the lake, some of their dwellings being near the lake, and others farther away. Now they remained there that winter. No snow came there, and all of their live-stock lived by grazing.

The Flat Island Book's description of Wineland is given in connection with Leif's supposed earlier voyage from Greenland:

At ebb-tide there were broad reaches of shallow water there, and they ran their ship aground there, and it was a long distance from the ship to the ocean; yet were they so anxious to go ashore that they could not wait until the tide should rise under their ship, but hastened to the land, where a certain river flows out from a lake. As soon as the tide rose beneath their ship, however, they took the boat and rowed to the ship, which they conveyed up the river, and so into the lake, where they cast anchor and carried their hammocks ashore from the ship, and built themselves booths there. They afterwards determined to establish themselves there for the winter, and they accordingly built a large house. There was no lack of salmon there either in the river or in the lake, and larger salmon than they had ever seen before. The country thereabouts seemed to be possessed of such good qualities that cattle would need no fodder there during the winters. There was no frost there in the winters, and the grass withered but little. The days and nights there were of more nearly equal length than in Greenland or Iceland. On the shortest day of winter the sun was up between "eyktarstad" and "dagmalastad."

Karlsefni, as we have already been informed, took with him "all kinds of cattle, as it was their intention to settle the country, if they could." Arrived safely at "Leif's booths," the Saga says they—

> carried their hammocks ashore there. They were soon provided with an abundant and goodly supply of food, for a whale of good size and quality was driven ashore there, and they secured it, and flensed it, and had then no lack of provisions. The cattle were turned out upon the land, and the males soon became very restless and vicious; they had brought a bull with them. Karlsefni caused trees to be felled, and to be hewed into timbers, wherewith to load his ship, and the wood was placed upon a cliff to dry. They gathered somewhat of all of the valuable products of the land, grapes, and all kinds of game and fish, and other good things.

In the Saga we find a note which would indicate that there was a third tradition regarding Karlsefni's expedition to Wineland which would subtract something from its romantic character but would lend strength to the belief that such a voyage was made. "Some say," the chronicler notes parenthetically, "that Biarni and Freydis remained behind here [at Streamfirth] with a hundred men, and went no further; while Karlsefni and Snorri proceeded to the southward with forty men, tarrying at Hop barely two months, and returning again the same summer."

The two main narratives agree strikingly regarding the topography of the country visited, and the climate, except that the Flat Island Book goes a little farther than the Saga by stating that there was no "frost" there, as well as no snow. It specifies salmon as the kind of fish they found in both lake and river and does not mention "halibut," probably in reality flounders, which were caught along shore. The Saga makes no mention of the "large house" Leif is supposed to have erected, nor of the stockade which Karlsefni's men put about it later. Finally, the Saga says nothing of those quantities of grapes and vines, upon which the Flat Island Book lays so much stress in connection with every visit to Wineland. The whale we may guess to be a more appetizing replica of Thorhall's at Streamfirth.

One of our critics finds fault with Leif for supposedly leaving his vessel aground on the sands while he and his men land to examine the country, but must a voyager always specifiy that he has left such and such a man behind to look after his vessel when he sets foot ashore?

Surprisingly little is said in any of the narratives regarding explorations in Wineland. During Leif's visit as narrated in the Flat Island Book we are, indeed, told that the leader undertook this systematically, but the exploring parties were limited to points from which they could return by night, and the story is a build-up for the discovery of grapes by the German Tyrker. An important exception is in the account of Thorvald's assumed Wineland visit. According to this narrative he and his companions reached Wineland in the summer and—

> remained there quietly during the winter, supplying themselves with food by fishing. In the spring, however, Thorvald said that they should put their ship in order, and that a few men should take the after-boat, and proceed along the western coast, and explore [that region] thereabouts during the summer. They found it a fair, well-wooded country; it was but a short distance from the woods to the sea, and [there were] white sands, as well as great numbers of islands and shallows. They found neither dwelling of man nor lair of beast; but in one of the westerly islands, they found a wooden building for the shelter of grain. They found no other trace of human handiwork, and they turned back, and arrived at Leif's-booths in the autumn.

The existence of a storehouse does not prove that there was a farming population in this country, since such buildings were used by the Indians for other purposes than the housing of cultivated cereals.

Since the Saga speaks only of explorations about Streamfirth, it has been thought by some that if there is any truth in the above narrative, it concerns explorations in that region, but the topography does not correspond. It rather suggests the southeastern coast of Massachusetts or some similar region. It is incredible that they expended no effort to extend their knowledge of the most delightful region they came in contact with.

The Wineland narratives concern themselves principally, however, with the inhabitants of that country, the people they call Skrellings. Here the two accounts show remarkable agreements and striking differences. According to each there were three encounters with these people, but the Saga states that the latter came by sea in skin canoes and the Flat Island Book that they arrived by land, out of the woods. On their first appearance, according to the Saga, the Skrellings did not land, but merely gazed at these new beings and then went away, on their second visit they were frightened away and turned hostile on account of the bellowing of a bull, and on their third appearance there was a fight. According to the Flat Island Book the Skrellings were frightened by the bull on their very first appearance and rushed to Karlsefni's house for shelter. He would not allow them to come in and presently they overcame their terror and laid down bundles of furs which they were carrying, whereupon a lively trade sprang up. They came back a second time to trade but fled because one of the Norsemen killed a Skrelling attempting to deprive him of his weapon. The third time they came to fight.

According to both narratives the Skrellings traded with furs, but according to the Saga the Norsemen purchased them with red cloth, while the Flat Island Book maintains it was with the milk of their cows. The Saga says nothing of the stockade which Karlsefni put up around his house after the first visit. Both agree that the Skrellings wanted to buy weapons but that Karlsefni and Snorri forbade the sale. According to the Saga the Norsemen were at first put to flight but were saved by an act of heroism on the part of Freydis, although only two Norsemen were killed while many enemies died. The Flat Island Book, however, indicates that Karlsefni arranged what must have been an ambuscade, 10 men showing themselves on a point of land near the sea while the remainder, fortified behind the redoubtable bull, concealed themselves in the forest. It seems that the attackers approached by land along the shore of the lake, between that and the forest, and were caught in flank by the Norsemen concealed in the woods and many of them were slain. This narrative implies, however, that they were ultimately frightened away by observing the effects of a Norse ax which the Skrelling chief, or one of the Skrelling chiefs, tested upon a companion with fatal effects. This episode, in somewhat different form, appears in the Saga. In that tale, however, the Skrelling wielding the ax is not said to have been a chief. He and his companions tried it out on a tree with satisfactory results, but when they attempted to use it on a stone it broke and they threw it away as of no value. In either form of this tale we have simply a Norse joke such as Indians often tell regarding the reactions of their own ancestors on first attempting to use European implements. But the Indians had axes and knew what to do with them, and they knew enough not to try them on stones or human beings, unless the human beings happened to be enemies or slaves.

During this encounter, as related by the Saga, the Skrellings resorted to a peculiar weapon the nature of which has caused much fruitless discussion. "The Skrellings raised up on a pole a great ballshaped body, almost the size of a sheep's belly, and nearly black in color, and this they hurled from the pole up on the land above Karlsefni's followers, and it made a frightful noise, where it fell." It was the fear which this aroused in the Norse which made them flee, so it would seem that the flight of both parties was based on superstitious dread. This aboriginal bomb finds representation in the Flat Island Book only in "a great crash" heard by those inside of the palisade during the second visit of the Skrellings. The Flat Island Book gives no intimation of the kinds of weapons used by these

Skrellings other than this, but the Saga says that they had "war-slings" and the skull of one Norseman, Thorbriand, Snorri's son, was cleft by a flat stone, presumably projected from one of these. And naturally, as the Skrellings are supposed to have advanced by land, nothing is said in the Flat Island Book of the "flails" of which the Saga speaks. It is interesting to note that one can make out the nature of the terrain on this first intercontinental battleground by close reading of the narratives. After the Norse had been frightened in the manner just indicated, the Saga goes on to say that "they could think of nought but flight, and of making their escape up along the river bank, for it seemed to them, that the troop of the Skrellings was rushing towards them from every side, and they did not pause until they came to certain jutting crags, where they offered a stout resistance," and after the victory they "returned to their dwellings, and bound up their wounds, and weighed carefully what throng of men that could have been, which had seemed to descend upon them from the land; it now seemed to them, that it could have been but the one party, that which came from the boats, and that the other troop must have been an ocular delusion." Now, the Flat Island Book says: "The lie of the land was such that the proposed meeting-place had the lake upon the one side, and the forest upon the other." The two narratives might be reconciled by supposing that the Skrellings had actually landed part of their company at some point from which they could come upon the Norsemen from the rear through the woods, while on leaving they all took to their boats. The nature of the country where the contest occurred seems evident, but there is some doubt as to which party ambushed which.

If we compare these two narratives on the ground of their relative plausibility, we find the balance inclines rather to the much-condemned Flat Island Book, aside from the cargoes of grapes with which the author of that narrative seems to have been obsessed. First, we do not know of skin canoes this far south. They belong to more northern regions. The weapons used also belong rather to the north, and the employment of flails swung in the air to declare war-like or peaceful intentions is otherwise unknown. These "flails" may have been spear throwers which are related to slings though never used so far as we know for hurling stones. They could hardly have been double paddles, for they are used with kayaks, and the skin canoes of these Skrellings do not seem to have been of that nature. Moreover, to continue our criticism, in making their attack, American aborigines would not ordinarily paddle in directly in front of the dwellings of their enemies. They would have come ashore some distance off and launched an attack from the land side in the early morning. As to the time of day we cannot say anything, but otherwise the Flat Island Book indicates the more probable maneuver unless on this point the Saga is to be interpreted as suggested above.

In the Flat Island Book there is mention of a supernatural visitant who appeared to Gudrid just at the outbreak of hostilities. Apparitions of this kind have been mentioned by both narratives in describing the events of the winter which Gudrid spent at Lysufirth, and it may possibly be explained by reference to these. The Saga tells us, it will be remembered, that Sigrid, the wife of Thorstein the Swarthy, sees the spirits of those of the company who had died that winter and among them her own although she was then living. It is possible, therefore, that the apparition which Gurid sees in Wineland and which calls itself Gudrid, although possessing some of the physical characteristics of the Skrellings in whose country this happened, was Gudrid's own ghost which came to indicate that her life was threatened, and its sudden disappearance a sign that events had postponed the sentence.

The nature of the Skrelling "bomb" has defied all attempts at explanation, though Schoolcraft thought he had discovered a clew in a former Chippewa custom. He learned that in their canoe fights these Indians sometimes used a big rock incased in skin which they elevated upon a pole and cast into an enemy's canoe in order to upset it. But there would be no point in hurling such an object upon the land, nor is there an adequate explanation of the loud noise which it made, impliedly due to bursting.

The use of milk by the Norsemen in trade has been ridiculed, but both narratives state that they had cattle with them, and milk would undoubtedly appeal to the aboriginal palate. The amount thus used in barter may very well have been exaggerated, the interest of the story turning, as in the case of the metal ax, on Skrelling reaction to a European novelty. On the face of it, trade in red cloth as described by the Saga is more probable, knowing as we do the fondness of our Indians for red fabrics, but one would like to inquire how Karlsefni learned in advance to provide himself with the amount of red cloth that is indicated. He was, indeed, a trader, but he had never had dealings with either Eskimo or Indians, and there is no evidence that he and his companions contemplated trade when they left Greenland. They are supposed to have anticipated settling in a country believed to be uninhabited. Traces of former occupants were found in Greenland when it was first settled but living Eskimo were not encountered until about 200 years later, and the other inhabitants of America were first revealed by this expedition.

Rupture of relations between the colonists and natives as the result of the slaughter of a Skrelling is more likely than that the bellowing of a bull should have caused it, though one writer has suggested that bovine animosity to the color red might have brought it about, since the Skrellings used the cloth they purchased largely to tie around their heads. On the other hand, since chroniclers normally prefer to record victories rather than defeats, the initial rout of the Norse in the final battle may perhaps indicate that the account of it in the Saga is more accurate, except for the direction from which the enemy approached.

The time of year when these events took place seems to be given more correctly in the Saga, judging by what we know of Indian customs. It places the first appearance of the Skrellings in the latter part of the summer in which the Norse came to Wineland or in the fall succeeding. They reappeared "when spring opened," and the attack was 3 weeks later. The Flat Island Book agrees that the aborigines put in their first appearance in summer, but this was "the summer succeeding the first winter" the white men spent in that country. Their second visit was made, however, shortly afterward "in the early part of the second winter," and the fight took place only a little later. If the third tradition is correct and Karlsefni and Snorri were in Wineland only 2 months, all this has to be enormously compressed. Finally it should be said that the differences in these narratives are the strongest points in their favor. They are factual but show no evidence of copying.

The Saga continues:

> It now seemed clear to Karlsefni and his people that, although the country thereabouts was attractive, their life would be one of constant dread and turmoil by reason of the [hostility of the] inhabitants of the country, so they forthwith prepared to leave, and determined to return to their own country. They sailed to the northward off the coast, and found five Skrellings, clad in skin-doublets, lying asleep near the sea. There were vessels beside them, containing animal marrow, mixed with blood. Karlsefni and his company concluded that they must have been banished from their own land. They put them to death.

Students do not seem to have discovered that a duplicate but much distorted account of this adventure has been inserted farther on in the Saga. It reads as follows:

> When they sailed away from Wineland, they had a southerly wind, and so came upon Markland, where they found five Skrellings, of whom one was

bearded, two were women, and two were children. Karlsefni and his people took the boys, but the others escaped, and these Skrellings sank down into the earth. They bore the lads away with them, and taught them to speak, and they were baptized. They said, that their mother's name was Vætilldi, and their father's Uvægi. They said, that kings governed the Skrellings, one of whom was called Avalldamon, and the other Valldidida. They stated, that there were no houses there, and that the people lived in caves or holes. They said, that there was a land on the other side over against their country, which was inhabited by people who wore white garments, and yelled loudly, and carried poles before them, to which rags were attached; and people believed that this must have been Hvitramannaland (White-men's-land), or Ireland the Great.[2]

Except for the finding of five Skrellings, this differs so much from the encounter just mentioned that it is not surprising that its real character has failed of detection. All the more as the event is placed in Markland, between Streamfirth and Greenland, and it has been assumed that Streamfirth was part of Wineland. But except in this one place the Saga never makes this last assumption. When Karlsefni was at Streamfirth, Thorhall is said to have left "in search of Wineland," and Karlsefni went south shortly afterward in quest of the same region. Although the Flat Island Book confuses the two to some extent, it is the southern region, where "Leif's booths" were erected, that is constantly called Wineland. The name is never used for a region farther north. The name "Markland" may have been employed in this episode because the event occurred in a wooded country—Markland may have been a general term covering Streamfirth and the territories north and south of it, or—and I believe this is the principal explanation—there has also been some confusion between this event and Karlsefni's later expedition in search of Thorhall during which Thorvald was killed.

It is to be noted that, if this episode and that regarding the two Gaels are removed from the Saga, little of the miraculous is left except for the events at Lysufirth in Greenland, and the adventure with the Uniped which itself is under some suspicion. We shall take that up below. The names reported as given by the Skrelling children look more like myth names than names of Indian or Eskimo extraction though the latter explanation is possible.

Reverting to the Saga, we find it noted next that, having killed the five Skrellings, Karlsefni's people "afterwards found a cape,

[2] "Or Ireland the Great" is omitted in one manuscript. For a careful discussion of Hvitramannaland or Ireland the Great see L. D. Scisco, "The Tradition of Hvitramannaland," in the American Historical Magazine, vol. 3, pp. 379-388 and 515-524, 1908. He concludes rather plausibly that the region originally intended was western Ireland.

upon which there was a great number of animals, and this cape looked as if it were one cake of dung, by reason of the animals which lay there at night." It is more likely that this was a bird rookery, the appearance of which is often described in these terms. Thus Stearns (1884, pp. 250-251) says of Shag Rocks on the southern coast of Labrador near St. Mary Islands where cormorants (or shags) bred in numbers:

At a distance these rocks present the appearance of being covered with snow, but a nearer approach shows that this is a covering of guano from the continual droppings of the birds; while the tops of the rocks are thickly embedded with an accumulation of guano from the same cause, firmly stamped down with the continual pattering of numberless feet.

"They now arrived again at Streamfirth, where they found great abundance of all those things of which they stood in need." Again the Streamfirth episode and all that happened between the departure of the colonists from Wineland and their arrival in Greenland is omitted by the Flat Island Book with the exception of one or two occurrences which appear, not in this connection, but in describing a supposed earlier expedition of Thorvald.

This introduces us to one of the most perplexing chapters in the Wineland sagas, the circumstances surrounding the death of this brother of Leif. The Saga of Eric the Red gives the story as follows:

Karlsefni then set out [from Steamfirth] with one ship, in search of Thorhall the Huntsman, but the greater part of the company remained behind. They sailed to the northward around Keelness, and then bore to the westward, having land to the larboard. The country there was a wooded wilderness, as far as they could see, with scarcely an open space; and when they had journeyed a considerable distance, a river flowed down from the east toward the west. They sailed into the mouth of the river, and lay to by the southern bank.

It happened one morning that Karlsefni and his companions discovered in an open space in the woods above them, a speck, which seemed to shine toward them, and they shouted at it; it stirred, and it was a Uniped, who skipped down to the bank of the river by which they were lying. Thorvald, a son of Eric the Red, was sitting at the helm, and the Uniped shot an arrow into his inwards. Thorvald drew out the arrow, and exclaimed: "There is fat around my paunch; we have hit upon a fruitful country, and yet we are not like to get much profit of it." Thorvald died soon after from this wound. Then the Uniped ran away back toward the north, Karlsefni and his men pursued him, and saw him from time to time. The last they saw of him, he ran down into a creek. Then they turned back; whereupon one of the men recited this ditty:

Eager, our men, up hill down dell,
  Hunted a Uniped;
Hearken, Karlsefni, while they tell
  How swift the quarry fled!

Then they sailed away back toward the north, and believed they had got sight of the land of the Unipeds; nor were they disposed to risk the lives of their men longer. They concluded that the mountains of Hop, and those which they had now found, formed one chain, and this appeared to be so because they were about an equal distance removed from Streamfirth, in either direction.

As already observed, the Flat Island Book version of this is inserted in an account of a supposed visit of Thorvald to Wineland. According to this narrative, the second summer they spent there they set out on an exploring expedition toward the north in course of which they came upon and named Keelness as already described. The narrative then continues as follows:

Then they sailed away to the eastward off the land, and into the mouth of the adjoining firth, and to a headland, which projected into the sea there, and which was entirely covered with woods. They found an anchorage for their ship, and put out the gangplank to the land, and Thorvald and all of his companions went ashore. "It is a fair region here," said he, "and here I should like to make my home." They then returned to the ship, and discovered on the sands, in beyond the headland, three skin-canoes, with three men under each. They thereupon divided their party, and succeeded in seizing all of the men but one, who escaped with his canoe. They killed the eight men, and then ascended the headland again, and looked about them, and discovered within the firth certain hillocks, which they concluded must be habitations. They were then so overpowered with sleep that they could not keep awake, and all fell into a [heavy] slumber, from which they were awakened by the sound of a cry uttered above them; and the words of the cry were these: "Awake, Thorvald, thou and all thy company, if thou wouldst save thy life; and board thy ship with all thy men, and sail with all speed from the land!" A countless number of skin-canoes then advanced toward them from the inner part of the firth, thereupon Thorvald exclaimed: "We must put out the warboards on both sides of the ship, and defend ourselves to the best of our ability, but offer little attack." This they did, and the Skrellings, after they had shot at them for a time, fled precipitately, each as best he could. Thorvald then inquired of his men, whether any of them had been wounded, and they informed him that no one of them had received a wound. "I have been wounded in my arm-pit," says he; "an arrow flew in between the gunwale and the shield, below my arm. Here is the shaft, and it will bring me to my end! But me ye shall convey to that headland which seemed to me to offer so pleasant a dwelling-place; thus it may be fulfilled, that the truth sprang to my lips, when I expressed the wish to abide there for a time. Ye shall bury me there, and place a cross at my head, and another at my feet, and call it Crossness for ever after." At that time Christianity had obtained in Greenland; Eric the Red died, however, before [the introduction of] Christianity. Thorvald died, and when they had carried out his instructions, they took their departure, and rejoined their companions [in Wineland], and they told each other of the experiences which had befallen them.

Thorvald's companions remained in Wineland during the following winter, and then went back to Greenland with the usual load of grapes and wood.

As these two narratives stand, apart from the beginning and end, the second is the more probable, Unipeds not having yet attained scientific status, and there being considerable mystery about the entrance and exit of this particular specimen. All the details in the Flat Island Book story are credible except the warning voice, and this might have been etherealized by the chronicler or might actually have been heard in a dream by Thorvald. Although the sleep from which the explorers were so rudely awakened is apparently supposed to have been supernaturally induced, we may read into it an early morning attack in accordance with Indian custom. Here, instead of in Wineland, the Flat Island Book introduces skin canoes. It has been assumed that the chronicler has transferred these from the Wineland experiences, but, except for the superior reputation acquired by the Saga, the reverse is the more probable, since skin canoes are known historically in the north instead of the south. If the "flails" of the Winelanders were spear throwers and they had slings, while the Marklanders fought with bows and arrows, the condition was exactly the reverse of what we should expect, spear throwers having been known in historic times among the Eskimo but not in New England. To be sure we do not know positively that the Markland arrows were projected by bows, but this seems to have been assumed by the chroniclers. The use of arrows here, be it noted, is affirmed by both documents. Both the Uniped and the Skrellings use them.

Mention was made above of the probable confusion between two different stories of an encounter with five Skrellings and the possible confusion of these with the story of the nine Skrellings met by Thorvald according to the Flat Island Book narrative. While these differ widely in details, there are suspicious cross-resemblances. In two of them five Skrellings are mentioned. In one the Skrellings are asleep, and the same may be assumed of the nine Skrellings who were found under their canoes. In all cases the Norsemen attack them, killing all in one case, and all but one in another, and capturing two in a third. While one of these encounters is said to have taken place between Wineland and Streamfirth, another is placed in Markland and the third in or near Markland.

After Karlsefni returned from the land of the Unipeds, he and his company—

passed the winter at Streamfirth. Then the men began to divide into factions, of which the women were the cause; and those who were without wives endeavored to seize upon the wives of those who were married, whence trouble arose. Snorri, Karlsefni's son, was born the first autumn, and he was three winters old [when they left].

After this comes the second story of the five Skrellings which, as I have already said, I believe to be a later insertion, and the Saga concludes the account of this voyage by saying, "Now they arrived in Greenland, and remained during the winter with Eric the Red." From the above it would appear that Snorri was born in the autumn of 1003 and it was in 1006 when they returned to Greenland. The Flat Island Book tells us that Snorri was born during the second summer his parents passed in Wineland which, following that document, would be in 1009, and the return to Greenland in 1010.

The Flat Island Book brings Karlsefni and his party directly to Greenland from Wineland the summer after their battle with the Skrellings. The Saga has nothing more to say regarding Wineland voyages. The rest of it is taken up with the fate of Biarni, Grimolf's son, who lost his life at sea in the foundering of his vessel, and an account of Karlsefni's return to Iceland with Gudrid and an enumeration of his descendants.

The fate of Grimolf's son has no particular bearing on our attempts to locate the several landfalls of the Norsemen in America except as it tends strongly to support the credibility of the Saga of Eric the Red in which it is related, for it tells us that his ship foundered because they "came into a sea, which was filled with worms." These "worms" were of course the teredo, and those who are now concerned with proofing timber against them will be interested in reading: "They had a boat, which had been coated with seal-tar; this the sea-worm does not penetrate."

The Flat Island Book, however, tells of another expedition to Wineland, one which had a tragic ending. According to this, during the summer in which Karlsefni returned from that country, a vessel came to Greenland from Norway commanded by two brothers named Helgi and Finnbogi. Freydis, Eric's daughter, induced them to undertake a voyage to Wineland the summer following. Both vessels arrived safely but during the winter Freydis compassed the death of the brothers and all their companions, male and female, and returned to Greenland the summer after that in their ship, laden with the products of the country. Freydis attempted to frighten those with her into silence regarding what had taken place, but Leif finally discovered it. He had no heart to punish her, it is said, perhaps on account of the service she had rendered Karlsefni and his men during the battle with the Skrellings, but it is added regarding her and her weak-minded husband—the two seem to have been counterparts of Lord and Lady Macbeth—that "no one from that time forward thought them worthy of aught but evil." This supposed voyage has elicited much hostile criticism, and we would fain wish that it might have been a work of the imagination, but unfortunately feminine human nature has shown itself to as ill advantage on more than one historic occasion, and a tragedy of this kind might help to account for the termination of visits to Wineland. Between the Skrellings and this horrible event they may have become associated with ill luck.

As in the case of the Saga, the last paragraphs of this narrative are taken up with the return of Karlsefni to Iceland and the story of his descendants. It differs, however, in inserting a visit to Norway where "he sold his wares, and both he and his wife were received with great favor by the most distinguished men of Norway." They then prepared to return to Iceland, but here an item of interest to us is introduced.

When all his preparations had been made, and his ship lying at the wharf, awaiting favorable winds, there came to him a Southerner, a native of Bremen in the Saxonland, who wished to buy his "house-neat" (a weather-vane, or other ornament at the point of the gable of a house or upon a ship). "I do not wish to sell it." said he. "I will give thee half a 'mörk' in gold for it," says the Southerner. This Karlsefni thought a good offer, and accordingly closed the bargain. The Southerner went his way, with the house-neat, and Karlsefni knew not what wood it was, but it was mösur, come from Wineland.

This is the "mausur" wood of which the Saga speaks. The latter begins its account of Wineland with a reference to this mysteriously valuable wood, generally regarded as maple, and perhaps bird's-eye maple, while the Flat Island Book here ends with an equally dramatic reference to it.

SUMMARY OF THE EXPEDITIONS

Before going farther I shall attempt an outline of the probable course of events of which these Wineland sagas profess to treat.

The Saga of Eric the Red is undoubtedly the more trustworthy of the two narratives, but this trustworthiness applies particularly to its treatment of the voyage of Karlsefni, and we may suspect that the story of Wineland was a much longer one and that many details have been suppressed. The relation of Leif's supposed discovery of Wineland would give the impression that he reached it after crossing the full breadth of the North Atlantic without coming in sight of any intervening lands, but we must suppose that he kept far enough to the north to be in the neighborhood of Iceland and the east coast of Greenland though apparently without sighting either. While such a voyage was possible it is highly improbable, and I am inclined to accept the story substantially as related in the Flat Island Book. All this requires us to believe is that a navigator called Biarni sailing west with the wind and ocean current in his favor was caught off the southern end of Greenland by a north wind and carried within sight of the Newfoundland coast and that, after sighting land in two more places, he finally reached Greenland. It is not necessary to accept all the details, but it is reasonable to suppose that Leif heard of this voyage and the new lands to the west and undertook to visit them himself, that he continued on farther south than Biarni to Nova Scotia or the New England coast, and that the Saga of Eric the Red has implanted a brief statement of the results of his expedition into the account of his return from Norway to Greenland, the one expedition having followed closely upon the other.

Leif's propagandizing work in Greenland was probably before this voyage. Whether he rescued the mariners at sea before or after it is of secondary importance, but there would have been an additional reason for calling him Leif the Lucky if he could report the discovery of a land of wood and grapes. Whether Biarni's voyage is or is not apochryphal, Leif was evidently the discoverer of Wineland, and to that discovery belong the two myths of the finding of grapes. As to the other events of Leif's voyage as told in the Flat Island Book, they are apparently mixed up with those reported for the voyage of Thorfinn Karlsefni except for the two first landfalls. It is quite certain that every Greenland navigator who visited Wineland carried back wood with him, and we are told in the Saga that Leif also took samples of self-sown wheat and vines.

The Flat Island Book has evidently mixed up the story of Thorbiorn's voyage to Greenland and subsequent settlement near Eric with that of the shipwrecked mariners. Neither story of the naming of Keelness is satisfactory. On one hand the drifting ashore of the keel from a European vessel on this part of the American coast is in the highest degree unlikely, and on the other, if the cape had been named by an earlier Norse expedition, Karlsefni should have known of the circumstances.

Since there is no mention of the voyage of Thorvald in the Saga, and since some of the events attributed to it are given by the latter as having happened during the expedition of Karlsefni, I omit it and place next the abortive venture of Thorstein, but am not sure whether the episode involving Eric's part in the expedition belongs here or with the earlier voyage of Leif. Here I am inclined, however, to follow the Flat Island Book and assume it was the latter, particularly as this authority tells us that Eric changed his intention to accompany the explorers and returned home. The Saga wishes us to believe that when Eric was thrown from his horse, some of his ribs were broken and his shoulder dislocated but that he was not deterred thereby from venturing out upon the tempestuous seas with Thorstein, and that the whole company, including apparently Eric, were "in high spirits." Leif might well have wished his fortunate father along, but the fact that Leif himself reaped the reputation for the discovery shows that Eric was not with him. We may follow the Saga in assuming that Thorstein did not marry Gudrid until after his return, and accept its version of their reason for going to Lysufirth to live, and the events which took place there, aside from the supernatural accompaniments. We should probably follow it in the main in its relation of the Karlsefni voyage, but should leave out the story of the two Gaelic runners and set down the second story of the five Skrellings as a later amplification of the first. I accept the narrative of Karlsefni's voyage to the north in search of Thorhall but would substitute the manner of Thorvald's death as related in the Flat Island Book for the adventure with the Uniped. However, there seems to be some confusion between the adventure with the nine Skrellings found under skin canoes and the two encounters in which five Skrellings figure. It is likely that real skin canoes were seen here for the first time, if at all, whereas those seen in Wineland were really of bark, or perhaps the Flat Island Book is correct in stating that the Wineland Skrellings always came through the woods. At least there seems to be evidence that their final attack was made by land, a maneuver which would be more in keeping with Indian strategy than a frontal assault. The aboriginal bomb may introduce a supernatural element impossible of explanation. The narratives agree that the main battle took place between the lake shore and a forest. If these Skrellings were armed with slings or spear throwers and those encountered farther north with bows and arrows, we have a curious violation of our expectations. Has the Saga inverted the facts and the Winelanders had bows and arrows while the northern Indians or Eskimo were provided with slings and spear throwers? Or did the southern Indians retain the use of slings and spear throwers after the northern Indians or Eskimo had adopted bows and arrows? A tantalizing insight is suggested into the history of weapons in America but it must remain such.

The exploration of the coast westward from Hop, as described in the account of Thorvald's voyage in the Flat Island Book, belongs probably to the voyage of Karlsefni and to a period before the Skrellings appeared, though it may have happened during Leif's expedition. Whether the encounter with the five Skrellings actually occurred, as the Saga indicates, during the return voyage from Wineland to Streamfirth, or was an event in the search northward of Streamfirth for Thorhall we cannot say, but I incline to the latter view. The cape covered with excrement was no doubt the breeding place of sea birds instead of the resort of animals. The principal event during the stay of Karlsefni's party at Streamfirth on their return to that place was the expedition in search of Thorhall and the death of Thorvald, which has already been alluded to.

I am not inclined to reject entirely the story of Freydis' expedition to Wineland, gruesome as it is. It is very likely that the tragedy which took place at that time may have converted the thought of Wineland the Good into the thought of Wineland the Unlucky, and may have added another inhibition to the fear of Skrellings and so prevented further exploitation of the country. It would, indeed, be surprising if only two voyages were made to Wineland. At least we know that Greenlanders sometimes ventured as far as Markland, for in the year 1347 a small Greenland vessel entered an Iceland fiord driven by storms after having visited Markland, and it is unlikely that it was the only one to attempt to bring wood from that country in later times.

CHRONOLOGY ACCORDING TO THE SAGA OF ERIC THE RED

999. Leif goes to visit Olaf Tryggvason in Norway.
999-1000. Winter spent in Norway.
1000. Leif returns to Greenland, visiting Wineland on the way.
1000-1001. Winter spent in Greenland.
1001. Thorstein Ericsson's fruitless expedition.
1001-1002. Winter spent in Greenland and at Lysufirth.
1002. Thorfinn Karlsefni comes to Greenland.
1002-1003. Winter spent in Greenland.
1003. Thorfinn Karlsefni reaches Streamfirth.
1003-1004. Winter spent at Streamfirth.
1004. Thorfinn Karlsefni reaches Wineland; Thorhall goes to Ireland.
1004-1005. Winter spent in Wineland.
1005. Thorfinn Karlsefni reaches Streamfirth on his return.
1005-1006. Winter spent at Streamfirth.
1006. Thorfinn Karlsefni returns to Greenland.
Possibly the dates after 1001 are too short by one year.

CHRONOLOGY ACCORDING TO THE FLAT ISLAND BOOK

985 or 986. Biarni's voyage from Iceland to Greenland via America.
999. Leif in Norway.
1000-1001. Biarni in Norway.
1001. Biarni returns to Greenland and Leif goes to Wineland.
1001-1002. Leif in Wineland.
1002. Leif returns to Greenland.
1002-1003. Leif in Greenland.
1003. Thorvald goes to Wineland.
1003-1004. Thorvald in Wineland.
1004. Thorvald explores coast to westward.
1004-1005. Thorvald in Wineland.
1005. Thorvald explores toward the north and is killed.
1005-1006. Thorvald's companions remain in Wineland.
1006. Thorvald's companions return to Greenland.
1006. Thorstein's fruitless voyage.
1006-1007. Thorstein and Gudrid at Lysufirth; Thorstein dies.
1007. Thorfinn Karlsefni comes to Greenland.
1007-1008. Thorfinn Karlsefni at Brattahlid in Greenland.
1008. Thorfinn Karlsefni reached Wineland.
1008-1009. Thorfinn Karlsefni in Wineland.
1009. Thorfinn in Wineland; war with Skrellings.
1009-1010. Thorfinn in Wineland.
1010. Thorfinn returns to Greenland.
1010-1011. All remain in Greenland.
1011. Freydis goes to Wineland with Helgi and Finnbogi.
1011-1012. In Wineland; Freydis kills Helgi and Finnbogi and companions.
1012. Freydis returns to Greenland; Thorfinn goes to Norway.
1012-1013. Thorfinn and Gudrid in Norway.
1013. Thorfinn and Gudrid go to Iceland.

AN ATTEMPT TO IDENTIFY THE REGIONS VISITED

When one considers the limited data one has to depend upon in attempting to locate the points visited by the heroes of these narratives and the plausible variations in interpretation of key portions of the original texts, the multiplicity of theories based upon them is easily explained, and the skepticism of certain writers readily understood. Nevertheless, a conservative discussion of probabilities will, I believe, yield some satisfactory results. At any rate I propose to attempt it. We shall have to depend almost entirely on the Saga of Eric the Red, and specifically on the story of Thorfinn Karlsefni contained in it, though the Flat Island Book will be found to yield evidence which is not to be ignored.

First I will introduce a table of items regarding the most important regions to be identified, wherein (S) signifies Saga of Eric the Red, and (F) the Flat Island Book.

DATA FOR THE IDENTIFICATION OF SITES MENTIONED IN THE WINELAND SAGAS

Note: A dœgr was 12-hours sailing time, but the distance covered in that time varied widely, being given as from 50 miles to 200.

HELLULAND:

2 dœgr from Bear Id. southward (S).
"Large flat stones, and many of these were twelve ells wide" (S).
"There were many Arctic foxes" (S).
3 dœgr from Markland; 4 from Greenland (F) (Biarni).
Reached from Markland with "southwesterly gales" (F).
"High and mountainous, with ice-mountains upon it" (F).
On turning away for Greenland they found this was an island (F).
On leaving they still had a southwest wind (F) (Biarni).
Leif found "no grass there" (F).
"Great ice mountains lay inland back from the sea, and it was a [table-land of] flat rock all the way from the sea to the ice mountains" (F).
To Biarni it seemed "entirely devoid of good qualities" (F).

MARKLAND:

Reached by sailing 2 dœgr from Helluland with northerly winds (S).
"Upon it was a great wood" (S).
"And many wild beasts" (S).
"An island lay off to the southeast, where they found a bear" and so named it Biarney (S).
According to one account 2 dœgr from next land; according to another apparently a coast continuous with it (S).
Reached by "a southerly wind" from Wineland (S).
2 dœgr from another land "level and covered with woods," and with "small hillocks upon it" (F) (Biarni).
Reached by a "fair," presumably south wind (F) (Biarni).
"A flat and wooded country" (F) (Biarni).
(Leif): "a level wooded land, and there were broad stretches of white sand, where they went, and the land was level by the sea" (F).
The land of the Unipeds seems to have been near or in it (S).

WONDER-STRANDS AND KEELNESS:

(Version 1): reached by sailing "southward for a long time." when they "came to a cape; the land lay upon the starboard; there were long strands and sandy banks there" (S).
Found keel of a ship upon the cape and called it Keelness (S).
Strands called Furdustrandir (Wonder-strands) "because they were so long to sail by" (S).
(Version 2): reached in 2 dœgr from Markland (S).
"They sailed off this land; there was a cape to which they came" (S).
"They beat into the wind along this coast, having the land upon the starboard side. This was a bleak coast, with long and sandy shores" (S).
(Naming of Keelness and Wonder-strands given same way) (S).

"Then the country became indented with bays" (S).

Gaels put ashore after passing Wonder-strands (S).

Thorhall sails from Streamfirth "past Wonder-strands and Keelness, intending to cruise to the westward around the cape" (S).

Karlsefni sails from Streamfirth in search of Thorhall "northward around Keelness, and then bears to the westward, having land to the larboard"; comes to a river flowing from east to west in wooded wilderness; sails "back to north" on leaving (S).

Thorvald's ship driven ashore by a high wind after he had set out from Wineland "toward the east" and "along the northern coast." The ship repaired there and keel set up upon cape, which is therefore called Keelness (F).

Sails "eastward off the land, and into the mouth of the adjoining firth, and to a headland covered entirely with woods" (F).

STREAMFIRTH (STRAUMFIORD), AND STRAUMEY (STREAM ISLE):

Coming to a country indented with bays they entered one at the mouth of which was an island "about which there were strong currents, wherefore they called it Straumey (Stream Isle). There were so many birds there, that it was scarcely possible to step between the eggs" (S).

"They sailed through the firth" (S).

Established themselves there for the winter with "all kinds of live-stock" (S).

"It was a fine country" (S).

"There were mountains thereabouts" (S).

"They occupied themselves exclusively with the exploration of the country" (S).

In consequence when "fishing began to fail they began to fall short of food" (S).

Capture a whale but made ill from eating it (S).

Situation improves later and "they could hunt game on the land, gather eggs on the island, and catch fish from the sea" (S).

Though Gaels had found grapes according to an earlier part of episode, Thorhall's ditty indicates that they had not (S).

Karlsefni "sailed for a long time" from here to reach Wineland (S).

To reach it he "cruised southward off the coast," and on his return "sailed to the northward off the coast" (S).

Returned to Streamfirth in spring or early summer, "and found great abundance of all those things of which they stood in need" (S).

Mountains in "Land of the Unipeds" believed to form one chain with those of Hop "because they were about an equal distance removed from Streamfirth, in either direction" (S).

Perhaps referred to in the following passages in (F): After leaving Markland they "sailed away upon the main with north-east winds," and sighted land after 2 dœgr. "They sailed towards this land, and came to an island which lay to the northward off the land" (F).

Dew sweet to the taste found there (F).

"They went aboard their ship again and sailed into a certain sound, which lay between the island and a cape which jutted out from the land on the north, and they stood in westering past the cape." (F). (The above may, however, have been in Wineland.)

WINELAND:

Leif is reported to have reached Wineland directly from Norway finding "self-sown wheat fields and vines growing there. There were also those trees there which are called 'mausur,' and of all these they took specimens. Some of the timbers were so large that they were used in building" (S).

This was in the summer of 1000 (S).

(Gaels said to have found self-sown wheat and grapes by running south from Streamfirth) (S).

Karlsefni comes to it by cruising southward "off the coast" from Streamfirth (S).

"They sailed for a long time" (S).

There was "a river, which flowed down from the land into a lake, and so into the sea. There were great bars at the mouth of the river, so that it could only be entered at the height of the flood-tide," so they called it Hop (S).

"They found self-sown wheat fields on the land there, wherever there were hollows, and wherever there was hilly ground, there were vines" (S).

"Every brook there was full of fish. They dug pits, on the shore where the tide rose highest, and when the tide fell, there were halibut in the pits" (S).

"There were great numbers of animals of all kinds in the woods" (S).

"They had their live-stock with them" (S).

"Skrellings" come "in skin-canoes, and staves were brandished from the boats, with a noise like flails, and they were revolved in the same direction in which the sun moves; when they came to fight these were revolved in the opposite direction" (S).

"They were swarthy men, and ill-looking, and the hair of their heads was ugly. They had great eyes, and were broad of cheek" (S).

They came from the southward around a point (S).

"No snow came there [the first winter] and all of their live-stock lived by grazing" (S).

The Skrellings bought red cloths, exchanging for them "peltries and quite gray skins"; bound cloth about heads (S).

They also desired to buy "swords and spears," but it was forbidden (S).

Skrellings scared away owing to bellowing of a bull and come back to fight (S).

"The Skrellings had war-slings" (S).

They raised on a pole "a great ballshaped body, almost the size of a sheep's belly, and nearly black in color." They hurled it up on the land "and it made a frightful noise, where it fell" (S).

Norse fled up along river bank "until they came to certain jutting crags, where they offered a stout resistance" (S).

Forest near the lake (S).

One Norseman had "his skull cleft by a flat stone" (S).

Had "delusion" of being attacked by another party from the forest (S).

On leaving the country Karlsefni "sailed to the northward off the coast" (S).

Find five Skrellings "clad in skin-doublets," and with "vessels beside them, containing animal marrow, mixed with blood" (S).

Mountains of Hop and those of Uniped country equally distant (from Streamfirth) (S).

"When they sailed away from Wineland, they had a southerly wind, and so came upon Markland" (S).

(F) See above for possible items.

"At ebb-tide there were broad reaches of shallow water there, and they ran their ship aground there, and it was a long distance from the ship to the ocean; yet were they so anxious to go ashore that they could not wait until the tide should rise under their ship, but hastened to the land, where a certain river flows out from a lake. As soon as the tide rose beneath their ship, however, they took the boat and rowed to the ship, which they conveyed up the river, and so into the lake, where they cast anchor and carried their hammocks ashore from the ship, and built themselves booths there. They afterwards determined to establish themselves there for the winter, and they accordingly built a large house" (F).

"There was no lack of salmon there either in the river or in the lake, and larger salmon than they had ever seen before" (F).

"The country thereabouts seemed to be possessed of such good qualities that cattle would need no fodder there during the winters. There was no frost there in the winters, and the grass withered but little" (F).

"The days and nights there were of more nearly equal length than in Greenland or Iceland. On the shortest day of winter the sun was up between 'eyktarstad' and 'dagmalastad'" (F).

They explore country no farther than each party can return in a day and a German among them finds grapes (F).

Each day they gathered grapes or "cut vines" and felled trees with which to load their ship (F).

Thorvald and his party supplied themselves with food their first winter in Wineland by fishing (F).

Next summer "a few men" take "the after-boat, and proceed along the western coast, and explore [the region] thereabouts during the summer. They found it a fair, well-wooded country; it was but a short distance from the woods to the sea, and [there were] white sands, as well as great numbers of islands and shallows. They found neither dwelling of man nor lair of beast; but in one of the westerly islands, they found a wooden building for the shelter of grain. They found no other trace of human handiwork, and they turned back, and arrived at Leif's-booths in the autumn" (F).

Next summer "Thorvald set out toward the east with the ship and along the northern coast," and came to Keelness (F).

Thorvald's companions return to Wineland, spend winter and take load of grapes and wood back to Greenland (F).

Karlsefni on going to Wineland took "all kinds of cattle, as it was their intention to settle the country, if they could" (F).

A whale of good size furnishes them with food (F).

"The cattle were turned out upon the land and the males soon became very restless and vicious; they had brought a bull with them" (F).

Wood was hewed into timbers and "placed upon a cliff to dry" (F).

"They gathered somewhat of all of the valuable products of the land, grapes, and all kinds of game and fish, and other good things" (F).

Skrellings come from woods, are frightened by a bull, and come with their packs to the house. They trade "gray furs, sables, and all kinds of peltries" for milk. They want to obtain weapons but this is forbidden (F).

Karlsefni has a palisade constructed about the house (F).

Karlsefni arranges a battle between the forest and the lake (F).

Return to Greenland with "vines, and grapes and peltries" (F).

A similar load brought back next year by Freydis (F).

Although written in a skeptical spirit, the treatment by J. P. McLean (1892, pp. 38-39) of early attempts to locate points in the Western World touched by the Norse makes a good introduction to this subject:

Torfæus who awakened interest in the subject in 1705, was content to place the scene in America, without even attempting to name the localities. In 1755, Paul Henri Mallet, in his "Histoire de Dannemarc", locates the scene in Labrador and Newfoundland. Robertson, in 1778, in his "History of America", although with misgivings, thinks "that the situation of Newfoundland corresponds best with that of the country discovered by the Norwegians." M. C. Sprengel (1782), in his "Geschichte der Entdeck Ungen", thinks they went as far south as Carolina. In 1793, Muñoz, in his "Historia del Nuevo Mundo", puts Vinland in Greenland. Barrow, in his "Voyages to the Arctic Regions" (1818), places Vinland in Labrador or Newfoundland. Hugh Murray, in his "Discoveries and Travels in North America" (1829), doubts the assigning of Vinland to America. Henry Wheaton (1831), in his "History of the Northmen", thought Vinland should be looked for in New England. Bancroft, the most eminent of American Historians, in the original third edition (1840) of his history, says "Scandinavians may have reached the shores of Labrador; the soil of the United States has not one vestige of their presence." Wilson (1862), in his "Prehistoric Man," declares that "Markland, . . . so far as the name or description can guide us, might be anywhere on the American coast," and that Nantucket is referred to is assumed, because they spoke of the dew upon the grass, because it tasted sweet. Foster, in his "Prehistoric Races of the United States" (1873), abruptly dismisses the subject, speaking of it as conjecture and no memorials having been left behind. Nadaillic (1883) speaks of the Norse discovery as "legends in which a little truth is mixed with much fiction." Weise, in his "Discoveries of America" (1884), believes the sea-rovers did not even pass Davis' Straits.

Attempts at identification by later writers are as follows:

IDENTIFICATION BY VARIOUS WRITERS OF REGIONS MENTIONED IN THE WINELAND NARRATIVES

Bear Id. or Ids. (Biarney) No. 1:
- Near Godthaab, Greenland: Storm, Babcock, Hermannsson.
- Disko: Graah, Bruun, Thórdarson, Power.
- Off Baffin Land: J. T. Smith.
- Southeastern Baffin Land: Steensby.

Helluland (Land of Flat Stones):
- Labrador and Newfoundland (two different regions): Rafn.
- Northern Labrador: Steensby, Hovgaard, Dieserud, Hermannsson, Thórdarson, Curran.
- Labrador and Northern Newfoundland: C. H. L. Jones.
- Labrador as a whole: Packard, Markham, Grenfell, Wallace, Storm, Babcock, Bruun, Fischer.
- Newfoundland: Howley, Horsford, Gathorne-Hardy (preferably), Kohl. (Howley says "in neighborhood of Pt. Riche or Flower Cove.")

Markland (Forest-land):
- Southeast Labrador: Steensby, Hermannsson, Grenfell, Hovgaard, Fernald, Thórdarson.
- Southeast Labrador or Newfoundland: Dieserud.
- Newfoundland: Packard, Nansen, Storm, Babcock, Fischer.
- Nova Scotia: Rafn, Hovgaard, Horsford, Gathorne-Hardy, Kohl, Packard (doubtfully).
- East of Penobscot Bay, Me.: Goodwin.
- James Bay Region: Curran.

Bear Island (Biarney) No. 2:
- Belle Isle: Thórdarson, Dieserud.
- Northern Peninsula of Newfoundland: Steensby, Hermannsson ("probably").
- Avalon Peninsula, Newfoundland: Babcock.

Wonder-strands (Furdustrandir):
- Labrador: Fernald, Grenfell.
- South Coast of Labrador: Steensby, Hermannsson, Thórdarson.
- South of Sandwich Bay, Labrador: Hovgaard.
- East Coast of Cape Breton Island: Storm.
- East Coast of Nova Scotia: Babcock, C. H. Jones.
- East Coast of Nova Scotia between Cape North and St. Ann's Bay: Dieserud.
- Between York River and Old Orchard Beach, Me.: Goodwin.
- Coast of Cape Cod: Horsford.
- Outer Coast of Cape Cod and Barnstable Co.: Gathorne-Hardy.
- West Coast of Hudson Bay: Curran.

Keelness (Kialarnes):
- Point Vaches: Steensby (stated doubtfully).
- East Cape, Anticosti Island: Hermannsson.

Cape Gaspé, Quebec Province: Thórdarson.
Cape Breton, N. S.: Storm.
Cape North, Cape Breton Island: Babcock.
Cape North or Cape Egmont, Cape Breton Island: Dieserud.
Cape Small Point, Me.: Goodwin.
Cape Cod, Mass.: Horsford.

STREAMFIRTH (STRAUMFIORD):
Chaleur Bay, Quebec Province: Hermannsson.
Sandwich Bay, Labrador: Hovgaard.
St. Lawrence Estuary: Steensby.
Miramichi Bay, Cocagne Harbor, or Shediac Bay, N. B.: Thórdarson.
Bay of Fundy, N. S.: Babcock.
St. Mary Bay, N. S.: C. H. L. Jones.
Mira Bay, N. S.: Dieserud.
Strait of Canso or a neighboring inlet, N. S.: Storm.
Portsmouth Harbor, N. H.: Goodwin.
Chatham Harbor, Mass.: Horsford.
Buzzards Bay, Mass.: Rafn.
Long Island Sound: Gathorne-Hardy.

STREAM ISLE (STRAUMEY):
Hare Island in St. Lawrence Entrance. Steensby.
Heron Island in Chaleur Bay: Hermannsson.
Grand Manan in the Bay of Fundy: Babcock.
Scatari Island, N. S.: Dieserud.
Newcastle Island in Portsmouth Harbor: Goodwin.
Island of spit south of Chatham, Mass.: Horsford.
Martha's Vineyard: Rafn.
Fishers Island in Long Island Sound: Gathorne-Hardy.

WINELAND (VINLAND):
Part of Labrador: Fernald, Grenfell.
About Rivière du Sud, Quebec Province: Steensby.
Southern Nova Scotia: Storm, Fischer.
Nova Scotia not farther south than Halifax: Dieserud.
Sop's Arm on the Northeast Coast of Newfoundland: Hovgaard.
Miramichi Bay, N. B.: Howley.
East Coast of New England: Thórdarson.
Plymouth Harbor, Mass.: Goodwin.
Cape Cod Region: Kohl.
East and South Parts of Cape Cod: Packard.
Back Bay Region, Mass.: Horsford.
Vicinity of Cape Cod or Long Island Sound: C. H. L. Jones.
Mt. Hope Bay, R. I.: Rafn, Babcock.
Region of Great Lakes: Curran.
(Mythic): Nansen.

RIVER OR FIRTH NORTH OF KEELNESS:
St. Lawrence Entrance: Hermannsson, Thórdarson.

One of the small rivers flowing into Northumberland Strait: Babcock, Dieserud.
Kennebec River, Me.: Goodwin.

Cross Point (Crossanes):
Pt. Alderton south of Boston Harbor, Mass.: Rafn.
South end of Georgetown Island, Me.: Goodwin.

In the bibliography at the end of this paper I have included only those works which have been referred to directly or indirectly. William H. Babcock and J. Fischer appended the titles of about 320 works to each of their respective publications. Besides the authorities included in my own list, which embraces only about 69 titles, I wish to make special acknowledgment to Dr. Harrison F. Lewis, Chief Federal Migratory Bird Officer of Ontario and Quebec Provinces, who has supplied me with some important information regarding the geography of the St. Lawrence region and the habits of the sea birds nesting there.

Let us see which of the identifications that have been attempted seem to stand up best under another examination of the material or whether in certain cases different ones might plausibly be suggested. The only sites which concern us and may be said to have been fixed beyond question are Ericsfiord and Heriulsfiord in Greenland (see page 6).

On leaving Ericsfiord Karlsefni is said to have voyaged first to the Western Settlement in the present Gothaab district, but as this lay in a direction contrary to his objective there has been much speculation among students as to his reason for doing so. It has been supposed that Gudrid, Karlsefni's wife, wished to visit a property she had inherited from her first husband which lay in Lysufiord, believed to be the present Ameralikfiord; that the voyagers wished to take advantage of more favorable winds and ocean currents; and possibly that they were aware of the narrowing of Davis Strait and the greater proximity of the American shores in that direction. It is known that Disko Island was called Bear Island and this has induced Bruun, Power, and Thórdarson to identify it with the Bear Island of the Saga, but most writers regard this as too far north. J. T. Smith suggests an island off Baffin Land, and Steensby inclines to view it as "a part of south-easterly Baffin Land." Hermannsson admits the possibility, mentioning specifically Resolution Island, but objects that the wording of the Saga assumes a previous knowledge of this island while it is intimated elsewhere that there was no knowledge among the Norsemen of the lands west of Davis Strait. Storm, Babcock, and Hermannsson therefore believe that it was some island or islands (one manuscript using the plural) off the Greenland coast near Godthaab (Brunn, 1918, p. 58; Power, 1892, pp. 175-176; Thórdarson, 1930, p. 15; Smith, 1839, map; Steensby, 1918, p. 34; Hermannsson, 1936, pp. 65-67; Babcock, 1913, pp. 54, 98). With this view I am inclined to agree, but the matter will probably never be settled. In any event it is of minor consequence.

Helluland is the first territory reached by Karlsefni known to have been west of Baffin Bay. The fact that this would be the most probable landfall for any vessel sailing southwest from Greenland, combined with the descriptions of the country as stony, without grass even, and with high "ice mountains" (Flat Island Book) upon it have led by far the greater number of investigators to identify it with Labrador or with some part of Labrador. The principal exceptions are the less conservative students who wish to extend Karlsefni's voyage as far to the south as possible and seek to make the descriptions square with Newfoundland. We should probably interpret "ice mountains" as "snowy mountains."

It is plain both from the documents and the name itself that Markland ("Forest-land") lay to the south of Helluland. Since forests begin in southern Labrador and extend southward indefinitely, theorizers have had a wide area of choice. Those who believe that the voyagers kept outside of Newfoundland have quite generally identified Markland with that island, but they have sometimes included southern Labrador on the supposition that the Strait of Belle Isle was unperceived and ignored. A few of the less conservative speculators, particularly those who place Helluland in Newfoundland, believe that Markland was Nova Scotia. Curran, who carries his explorers boldly through Hudson Strait into Hudson Bay, finds Markland in the James Bay region. Steensby and his followers, believing that Karlsefni entered the Gulf of St. Lawrence through the Strait of Belle Isle, confine Markland to southern Labrador (Steensby, 1918, pp. 42-47; Hermannsson, 1936, p. 59; Thórdarson, 1930, p. 21). Others have doubted, or discounted, this on the ground that the Labrador forest growth is small and is almost absent from the offshore islands and the headlands. The official map of Canadian forests (Atlas of Canada, pp. 17-18) shows, however, "densely wooded northern forest" between Hamilton Inlet and Sandwich Bay. H. G. Watkins (1930, p. 98) reports that—

> southern Labrador is so thickly wooded that it is impossible to do any plane-table work. Even the high hills are usually covered with trees, and for the most part it is an undulating country with no outstanding peaks.

As a result of exploration in the peninsula, A. P. Low (1896, p. 31L) says:

> The forest is continuous over the southern part of the peninsula to between latitudes 52° and 54°, the only exceptions being the summits of rocky hills and the outer islands of the Atlantic coast. To the northward of latitude 53°, the higher hills are treeless, woods being only found about the margins of small lakes and in the valleys of the rivers. Trees also decrease in size until, on the southern shores of Ungava Bay, they disappear altogether.

Packard (1891, pp. 118, 125, 140) reports of the shores of Anse-au-Loup in the Strait of Belle Isle that they seemed to be "well wooded." Again:

> The lumber for these shanties [in Pitt's Arm of Temple Bay] had evidently, by the piles of sawdust near by, been sawn upon the spot and taken from the Labradorian forest of firs near at hand, which measured twelve inches through at the butt, and were about twenty feet high.

At the head of a bay near Cape St. Michaels was "quite a forest of spruce." From W. A. Stearns (1884, pp. 98, 117) I quote the following:

> From the entrance of the bay [of Bonne Esperance] then, as I have said, we caught a view of the Indian mishwaps [dwellings], backed by the verdure of slopes, hills, ravines, ridges, and the various contour of a most uneven background in the profile of the evergreen spruce tops,—which low shrub is everywhere abundant outside as is the large tree inland. . . . Those who can obtain wood near by without the necessity of going into the interior up the river, and rafting it down, as many of them do, content themselves with a smaller article, and continue to make clearings in the low spruce and fir about their own place. The majority of this wood varies from four to six and even seven inches in diameter, while the trees are rarely over fifteen feet in height.

Greenland visitors to this coast were not likely to be too demanding as to the size of trees or extent of forest in a country better blessed then their own.

The Flat Island Book in its narrative of Leif's voyage adds to the description of Markland that "there were broad stretches of white sand where they went." Unless this is reminiscent of the Wonder-strands, we may find it in the sandy shores reported around Sandwich Bay, but I incline to the former view.

An island off the coast of Markland was given the name of Bear Island from the circumstance of their having killed a bear upon it, and this is therefore Bear Island No. 2. Those who think that Karlsefni passed through the Strait of Belle Isle identify this either with the northern peninsula of Newfoundland or with Belle Isle itself, and Dieserud holds the latter view although he carries the explorers south outside of Newfoundland. Others of this school seem to avoid theorizing on the point except Babcock (1913, pp. 108-109), who suggests an identification with Avalon Peninsula which he supposes was taken to be an island.

Differences of opinion among investigators become more marked when they take up points beyond Markland, including the Wonder-strands, the cape named Keelness (Kialarnes), Streamfirth (Straumfiord), Stream Isle (Straumey), the river or inlet in which Thorvald was killed, and Hop or Wineland. The voyagers made two lengthy stops during this part of their journey, one at Streamfirth and the other at Hop or Wineland. We will discuss the location of these in order, but it is to be noted at the very beginning that the Flat Island Book seems to confuse them, identifying both with Wineland, and therefore we must depend more than ever upon the Saga in our discussion of the whereabouts of the former. Here our more careful students fall into two schools, one maintaining that Karlsefni kept east of Newfoundland, that the Wonder-strands were on the outer coasts of Cape Breton Island and Nova Scotia, one or both, and Streamfirth was either the Bay of Fundy as Babcock (1913, p. 118) has it, or some bay in southern Nova Scotia—Mira Bay, thinks Dieserud (1901, p. 12), St. Mary Bay according to Jones and Raddall (1934, p. 106). According to the second school, Karlsefni entered the Gulf of St. Lawrence through the Strait of Belle Isle, the Wonder-strands were on the south coast of Labrador, and Streamfirth was the estuary of St. Lawrence River, Chaleur Bay, or one of the bays south of the latter.

Strong arguments can be brought forward in favor of each of these theories, and it happens, unfortunately, that the two versions of the Saga differ just at this point sufficiently to support both. The Hauk's Book version informs us that, after leaving Markland—

> they sailed southward along the land for a long time, and came to a cape; the land lay upon the starboard; there were long strands and sandy banks there. They rowed to the land and found upon the cape there the keel of a ship, and they called it there Kialarnes (Keelness); they also called the strands Furdustrandir (Wonder-strands) because they were so long to sail by. Then the country became indented with bays, and they steered their ships into a bay. . . . .

The second version is as follows:

> When 2 dœgr had elapsed [after leaving Markland], they descried land, and they sailed off this land; there was a cape to which they came. They beat into the wind along this coast, having the land upon the starboard side. This was a bleak coast, with long and sandy shores. They went ashore in boats, and found the keel of a ship, so they called it Keelness there; they likewise gave a name

to the strands, and called them Wonder-strands, because they were long to sail by.

The first version gives us to understand that the Wonder-strands, including Keelness, were on land continuous with Markland and there was no break in the coast. That is what we should expect if Karlsefni entered the Strait of Belle Isle and kept on along the southern coast of Labrador. According to the second version, however, there was open sea or a broad inlet between Markland and the Wonder-strands, and this favors the Nova Scotia theory. It would not, of course, take 2 dœgr to pass the Strait of Belle Isle, but in order to reach Nova Scotia from Newfoundland it would have been necessary to cross Cabot Strait and this might well have taken the time indicated. Although confounded with the later stay at Hop, the events which took place in the region we are studying are covered by the Flat Island Book in a few sentences, and these may be interpreted to favor both theories. After leaving Markland we are told:

They returned to the ship forthwith, and sailed away upon the main with northeast winds, and were out two "dœgr" before they sighted land. They sailed toward this land, and came to an island which lay to the northward off the land.

The "2 'dœgr' " may be quoted in confirmation of the second version of the Saga. It happens, however, that in describing Markland just before this, the Flat Island Book, besides stating that it was "a level wooded land," adds "there were broad stretches of white sand, where they went, and the land was level by the sea." This happens to be the only mention of sandy beaches in connection with Markland, but in the confused state of the Flat Island narrative and remembering that the Wonder-strands are described in the first version of the Saga as continuous with Markland, one can use this to confirm the topography of that version.

The Nova Scotia theory derives considerable strength from what is said of the expedition of Thorhall from Streamfirth "in search of Wineland" and Karlsefni's subsequent search for him. According to the Saga, Thorhall "sailed away to the northward past Wonder-strands and Keelness, intending to cruise to the westward around the cape." It would appear from the ditty supposed to have been composed by Thorhall on this occasion that his real object was to return home, but an intention to hunt for Wineland might have been his excuse, and if the explorers crossed Cabot Strait on their way to Nova Scotia without having entered it, the possibility that Wineland was to be found by sailing through it was plausible. In his search for

Thorhall next summer Karlsefni pursued the course that the former was supposed to have taken. He and his companions—

sailed to the northward around Keelness, and then bore to the westward, having land to the larboard. The country there was a wooded wilderness, as far as they could see, with scarcely an open space, and when they had journeyed a considerable distance, a river flowed down from the east toward the west. They sailed into the mouth of the river and lay to by the southern bank.

Westward-flowing streams are scarce along the northeast coast of America but there are some flowing into Northumberland Strait that might answer to the description, and Thorvald's enthusiasm over the region they entered, in the Flat Island Book, would be justified. At the other end of Nova Scotia the Bay of Fundy with its renowned tides would fit ideally with what is said of Streamfirth, but I doubt whether the tides on the outer coast of Nova Scotia are sufficiently conspicuous to encourage us to choose St. Mary Bay or Mira Bay. If the Bay of Fundy was Streamfirth, we could find a bird island in one of the Tusket Islands but hardly in Grand Manan as Babcock (1913, pp. 118-120) suggested.

A weak point in the theory is the supposition that our voyagers passed all the way round the irregular east and south coasts of Newfoundland without comment. The most serious objection, however, arises when one attempts to identify the Wonder-strands with the modern topography. A long, relatively straight, and to some extent sandy, coast is indicated. This excludes the coast of Newfoundland and compels us to seek for it on the east coasts of Cape Breton Island and Nova Scotia. This is a stumbling block even if we agree with Dieserud, as does the writer, that Wonder-strands does not necessarily mean Wonder-sands and we need not look for long sandy beaches like those of New Jersey or even southern Maine and New Hampshire. Dieserud (1901, p. 12) is able to cite the existence of one sandy beach of at least a mile in length in Ingonish Bay and places Wonder-strands between Cape North and St. Ann's Bay on the northern projection of Cape Breton Island, but that is some distance from the long, straight coast we are led to search for which would begin at Cape Breton, and it seems hardly extensive enough to answer to the language used. Babcock (1913, pp. 112-117) sought a different solution by supposing that the configuration of the east coast of Nova Scotia had been radically altered since A. D. 1000 by the rising of the land. He was in error in supposing that the land is rising. It is actually sinking (Dr. Lewis, personal communication). But this need not destroy the force of the theory if it can be shown that when the land was higher, the coast line was in keeping with the description in the Saga. Nevertheless, it would not seem that men from Greenland who had recently passed along the Labrador coast would describe that of Nova Scotia as "bleak" as does one version of the Saga. A minor criticism is furnished by the fact that the Flat Island Book seems to say that they sailed west into Streamfirth, whereas the Bay of Fundy extends from southwest to northeast. In view, however, of the uncertain value of so many Flat Island Book statements this must not be overrated. On the other hand, I have omitted one argument in Nova Scotia's favor which will appear when we come to take up the problem presented by Wineland.

What may be called the Labrador theory of the location of the Wonder-strands was first proposed by Steensby, and it has been accepted by a number of the best subsequent students such as Hermannsson and Thórdarson (Steensby, 1918, pp. 42-47; Hermannsson, 1936, p. 59; Thórdarson, 1930, p. 21). It derives its great strength from the fact that the southern Labrador coast is relatively straight, long, and "bleak," but particularly because one can here point to a considerable number of long sandy beaches. Dr. Lewis has kindly supplied me with data regarding these which are as follows.

	Miles
Blanc Sablon Bay	1
Anse des Dunes, Bradore Bay	1
Sandy Island, St. Augustin	1
Vicinity of mouth of Netagamiu River	8
Kegaska Bay to Natashquan	31
Vicinity of mouth of Agwanus River	9
Clearwater Point to west of Eskimo Point	9
Mingan River to Magpie	23
Matamek to Bay of Seven Islands	26

The first considerable stretch of sand occurs just east of Cape Whittle, where the trend of the coast as one enters the Bay of St. Lawrence changes from southwest to west, and from Kegaska Bay on, sand beaches are fairly numerous and long. East of Netagamiu River the coast is generally bold, rocky, and desolate. I quote the following from Packard (1891, p. 63) regarding this part of the coast:

As we approach land no capes run out to greet us, or sheltered harbor opens its arms to embrace. An uninterrupted line of coast confronts the gulf. In one place alone is the intense monotony of the outline relieved by the hills of Bradore, where the coast sweeps round fifteen miles to the eastward, and the Strait [of Belle Isle] widens out.

The total distance from the eastern entrance of the Strait of Belle Isle to Cape Whittle is about 225 miles, and from Cape Whittle to Seven Islands 280 miles, 98 of this latter consisting of sand beaches. Undoubtedly this fits the description of the Sagas better than any other location that has been suggested and that has any probability in its favor.

We have considerable difficulty, however, in determining the location of Keelness, because the narratives leave us in some doubt whether it was at the near or far end of the Wonder-strands as the voyagers approached it or whether it lay in an intermediate position. Those who place Wonder-strands on the south coast of Labrador have uniformly located it at the western end because they have thought it necessary to identify the western wooded land visited by Karlsefni with the estuary of the St. Lawrence, though there has been no agreement among them as to the identity of the cape. Steensby, somewhat doubtfully, suggested Point Vaches at the mouth of the Saguenay River, but this is by no means conspicuous, nor is it easy to see how an explorer from the south could pass around it and turn west. Here Steensby has felt compelled to resort to an elaborate reconstruction of the narrative which is labored and has been accepted by no one else. Hermannsson proposed the East Cape of Anticosti Island, his theory being that the voyagers sighted it as they passed westward along the Labrador coast, cut across to it under the impression that it was the south headland of a bay, and from there entered Chaleur Bay which he identifies as Streamfirth. On leaving in search of Thorhall he thinks Karlsefni rounded the same cape as being a known landmark and then turned west into the St. Lawrence estuary unaware of the shorter route between Anticosti and Gaspé. Thórdarson, however, esteems it incredible that Karlsefni's company who had, according to the narrative, spent all their first summer exploring the country, should have been unaware of this wide passage. He accordingly identifies Keelness with Cape Gaspé but otherwise agrees with Hermannsson as to the location of the region of the Unipeds visited by Karlsefni (Hermannsson, 1936, p. 68; Thórdarson, 1930, pp. 25, 36). Thórdarson's emendation seems logical, and it has the same strength as the Nova Scotia theory in being able to point to a western inlet for exploration by parties in search of Wineland—in this case the St. Lawrence estuary rather than the entire Gulf of St. Lawrence. Indeed, Steensby (1918, pp. 64-76) locates Hop higher up this very estuary but thereby is left without any proper explanation of the region covered by Karlsefni in his search for Thorhall, since this lay to the north of Streamfirth, while Hop, from which he had recently come, was far to the south.

One difficulty with the theories of Hermannsson and Thórdarson is that they fail to indicate an inlet corresponding sufficiently well with the Streamfirth of the Sagas. Chaleur Bay is ideal from the point of view of climate and the presence of pasture lands suitable for the Norsemen's cattle, but although the tides rise 10 feet near its head, they are much lower at its entrance, and the currents are not conspicuous. Heron Island, which is suggested as the Stream Island of the explorers, is near the head of the bay, whereas the narratives place Stream Island close to the entrance, and I am informed by Dr. Lewis that it is too large for a bird rookery. The latter criticism would also apply to Miscou Island at the mouth of Chaleur Bay. On the other hand Miramichi Bay, Cocagne Harbor, and Shediac Bay, suggested by Thórdarson (1930, pp. 37-38) are not particularly noted for their currents. Those in Shediac Bay are reported to be "weak," and although there is considerable current at times in Miramichi Bay, the tides rise only 4 to 6 feet. Nor are the islands at the mouth of these bays suitable for bird nesting places. Moreover, as Thorhall indicates in his ditty, Streamfirth was close to Wonder-strands. Both of these thories also suffer from the fact that they separate Keelness farther from Wonder-strands than the narratives warrant. The first version of the Saga speaks of the cape before it mentions the strands, the second version speaks of them together; Thorhall and his men "sailed away to the northward" past Wonder-strands and Keelness, intending to cruise to the westward around the cape, and Karlsefni, when in search of him, is said to have rounded the cape and voyaged west, although here nothing is said of Wonder-strands. The two last references imply that the cape was at the extreme eastern end of the strands, and that one could steer west immediately after passing it, but this may not have been the case, since the first version of the Saga says that after leaving Markland "they sailed southward along the land for a long time" before coming to the cape, and the wording of the second version is not averse to such an interpretation, while both apparently intimate that if Keelness was not on a sandy coast, sand was not far away. I would suggest as a solution that Keelness may have been at or near Cape Whittle, that the coast along which the Hauk's Book narrative says they sailed "for a long time" after leaving Markland was that part of the Labrador coast east of Cape Whittle. Since this section of the coast trends southwest, the statement that they were following it "southward" would not be too much out of line. An exact identification of this cape I shall not attempt, merely placing it somewhere between Netagamiu River and Natashkwan Point. It is true that the later references to Keelness would lead us to suppose that navigators could turn directly west after rounding it, but we do not have to interpret such statements too literally. If we could be sure that Thorhall was genuinely bent on sailing westward after passing Keelness, the fact that he was driven to Ireland shows, on the Labrador theory, that he passed through the Strait of Belle Isle in pursuit of his object, for we cannot believe that he was driven through that strait against his will. This, it may be observed, applies still more forcibly to the theories of Steensby, Hermannsson, and Thórdarson, since, if we accept them, we have to assume that Thorhall was driven across the entire expanse of the Gulf of St. Lawrence and through the Strait of Belle Isle or Cabot Strait, and across the Atlantic on top of that. Our only escape from this would be to suppose that Thorhall did not intend to turn westward but made for the open ocean.

Our documentary sources give no warrant for the assumption that Keelness was separated from the Wonder-strands by an inlet. If Keelness was at or near Cape Whittle, we must look for the river or inlet into which Karlsefni sailed in search of Thorhall somewhere east of it, and unless we can identify it with the estuary of some river like the St. Augustin, we shall have to suppose that they reached Sandwich Bay or Hamilton Inlet. Probably one would not think of this as a region to excite the admiration Thorvald is said to have expressed, but it differs from the surrounding parts of Labrador in harboring a dense forest, and in spite of the length of the voyage required to reach it, it is not to be excluded as a possibility in locating the land of the Unipeds. It suffers in our eyes in comparison with the St. Lawrence estuary or Nova Scotia but may have made a different impression on the mind of a Greenlander.

As opposed to the attempted placement of Keelness by Steensby, Hermannsson, and Thórdarson, the Nova Scotia theorizers can point to a very satisfactory Keelness at the northern end of Cape Breton Island, and in addition to that to a very satisfactory Streamfirth in the Bay of Fundy (Babcock, 1913, p. 110), but unless they can resurrect out of the geological past a coast line on the seaward side of Nova Scotia much more in keeping with what we are told of Wonder-strands than anything found there today, the theory is fatally defective.

Indeed, the southern coast of Labrador seems to be the only one in the entire St. Lawrence region that in any way fits the documentary descriptions. Moreover, it has all the strength of the Nova Scotia theory in being immediately connected with a tidal inlet corresponding to Streamfirth whether we identify it with the strait north of Anticosti Island or look for it higher up in the St. Lawrence estuary. Jacques Cartier (Biggar, 1924, p. 74) gives testimony to the strength of tides in the former in the record of his first voyage. His longboats were sent ahead of the vessels to row up to the head of Anticosti on its northern side, but—

> when we had rowed along the said coast for some two hours, the tide began to turn and came against us from the west so violently that it was impossible to make a stone's throw of headway with thirteen oars. And we deemed it advisable to leave the long-boats, with part of our men to stand guard over them, and for ten or twelve of us to go along the shore as far as that cape where we found that the coast began to turn off towards the south-west [i.e., to North Point on Anticosti]. When we had seen this, we made our way back to our long-boats and returned on board the ships, which were still under sail, hoping always to make headway; but they had drifted more than four leagues to leeward from the spot where we had left them.

The tides in the St. Lawrence estuary are stronger yet, attaining their maximum at the mouth of the Saguenay where they reach a velocity at times of 6 or 7 knots an hour (St. Lawrence Pilot, 1924, p. 411).

Either of these locations would fit the statements in the narratives which give us to understand that Streamfirth was near the Wonder-strands and that it was entered immediately after passing them. The Saga says: "Then the country became indented with bays, and they steered their ships into a bay." On reading this some have supposed that the voyagers passed a number of bays and chose to enter one of them. I think, however, that the first part of the sentence is merely introductory to the second. They had been sailing along what seemed to them an open coast, and afterwards came to a part of it where bays began and they sailed into one of them which we may equally well suppose was the first.

The Saga continues:

> There was an island out at the mouth of the bay, about which there were strong currents, wherefore they called it Straumey [Stream Isle]. There were so many birds there, that it was scarcely possible to step between the eggs. They sailed through the firth, and called it Straumfiord [Streamfirth], and carried their cargoes ashore from the ships, and established themselves there. They had brought with them all kinds of live-stock. It was a fine country there. There were mountains thereabouts. They occupied themselves exclusively with the exploration of the country. They remained there during the winter, and they

had taken no thought for this during the summer. The fishing began to fail and they began to fall short of food.

Thorhall the Huntsman exerts his pagan charms and a whale is found, but the colonists are made sick by eating its flesh, they throw all away into the sea, and appeal to God, whereupon:

The weather then improved, and they could now row out to fish, and thenceforward they had no lack of provisions, for they could hunt game on the land, gather eggs on the island, and catch fish from the sea.

Bird islands are so common in the St. Lawrence region that it would be impossible to find the one here described even though the identity of Streamfirth is correctly established. One of the narratives, instead of speaking of birds, mentions specifically eider ducks. Steensby seeks to identify the bird island with Hare Island which lies just above the mouth of the Saguenay but Dr. Lewis tells me that it is too large to be a favorite resort of nesting birds.

While the estuary of the St. Lawrence corresponds very satisfactorily with the Streamfirth of the narratives, we must assume that, if the Norse were there, they did not carry their explorations far enough toward the head of the Gulf to discover that a mighty river poured into it. Some question may be raised as to the possibility of carrying cattle over the winter in that section, but this part of the Gulf region certainly has a more favorable climate than is commonly supposed. The Canadian zone of vegetation succeeds the Hudsonian here and extends up along the coast to Cape Whittle, while the southern forest area passes beyond Pte. des Monts (Atlas of Canada, 1915, pp. 17, 18). The relative mildness of the Mingan section, for instance, is thus described by Stearns (1884, pp. 256-258):

On the mainland, or Mingan proper, contrary to what might be expected from the appearance of the island opposite, an entirely different formation exists. Nowhere along the coast, for a considerable distance at least, does a rock of any size appear, either in place or loose as bowlder, stone, or pebble. Strange to say, as will be shown further on, the rocky precipices, or rather steps of the rapids in Mingan river, some three miles from its mouth, seem to be the first indications of rock formation in this locality, while these are simply the eastern and southeastern boundary of a tremendous mass of high rocky ground that extends inland for miles, perhaps thousands of miles.

The coast and its beach, as the whole country to the rocks inland, is everywhere low and sandy. On the beach itself the sand is dense and very fine. Farther in shore there is a very scant, occasional streak of low vegetation where are pastured a few heads of cattle and goats that graze on the lawns, here and there, where they can find food. A few acres of good grass are fenced in, and this supplies an excellent feed for the animals during the winter, which here is neither so long nor so severe as is usually the case farther north, at

Bonne Esperance even. From Mingan west to Long Point, a distance of about six miles, this low sand beach extends almost without a single rock, I believe, while the east beach is entirely of sand. The river itself passes through a ridge of this same material which forms a high bank on the left and a low one on the right, as one passes inland, while the whole land rises directly from the sea then falls in a northeasterly direction, and the trend of greatest height, here, as nearly everywhere along this part of the coast, is in a northwesterly direction. In the background, the distant hills rise to the height of at least a thousand feet, while dim outlines of others, of perhaps greater height, appear in the horizon. This is the picture whose charming outline at once attracts and captivates one upon entering the harbor of this sequestered little spot. . . .

At the mouth of both rivers [the Mingan and Romaine] are shallows and accumulations filling the water with ridges that control strongly the current at this point. These sand bars are constantly shifting, while in places they have overrun each other and piled up small islands of sand which becoming overgrown with grass or scant vegetation have become the nesting places of gulls and ducks, thus supplying the people with birds and eggs in large numbers whenever they are desired. Following up the river [Mingan] you will find sand and sand banks on either hand, and extending, with scant vegetation, far inland. . . . .

"From the shore [at the mouth of Mingan River] we could see the summit of Mt. St. John's, lying some fifteen miles inland in a northwesterly direction, which mountain is said to be a little over fourteen hundred feet in height. Directly inland the country is said to rise in successive steps—if one might use the word in this connection,—to what is termed the "height of land," some five hundred miles inland, where a chain of mountains, peculiar to the whole lower St. Lawrence region, and northerly Quebec, with peaks varying from one to three thousand feet in height, continues in an eastern trend towards the sea, which it reaches at the extremity of the Labrador peninsula, near Ivucktoke, or Hamilton Inlet.

Here we have sufficient feed for a few cattle at least, bird islands, strong tides, and a background of mountains. A place possessing somewhat similar advantages is Seven Islands, farther west, a former Indian gathering place, and there are other places suitable for settlement such as the Greenlanders were attempting higher up on both sides of the river. I think there is no doubt that we are in the immediate region of Streamfirth even if we cannot carry our identification any closer.

In transferring the sites of Wonder-strands, Keelness, Stream Isle, and Streamfirth from Newfoundland and Nova Scotia to points inside the Gulf of St. Lawrence, Steensby performed a distinct service to all students of the Wineland voyages, but when he goes on to place Wineland in the same region, only farther up toward the mouth of the river, like Hermannsson and Thórdarson, I fail to follow him. Carried far enough it would bring the voyagers into a wild-grape country but, at the same time, to a certain knowledge of the great river, and of this the Sagas contain no trace. Moreover, Steensby does not seem to have noticed that such a location would be in violent contradiction with what is said about Leif's discovery of Wineland in the Saga of Eric the Red which Steensby accepts as authoritative. For it tells us that he came upon that region after having been tossed about for a long time on the North Atlantic when he was on his way from Norway to Greenland, and it is evident that he would not have been driven through Cabot Strait and deep into the Gulf of St. Lawrence, or of his own volition would have voyaged thither. This objection would, indeed, be removed if we accept the story of Leif's discovery of Wineland substantially as it is given in the Flat Island Book, but there are other serious difficulties, one being the failure of the Norse to discover the St. Lawrence as noted above and another the short distance between Steensby's sites at Hare Island and the mouth of the Rivière du Sud, where he places Hop. This is less than 90 miles, far from sufficient to require a voyage that could be described as occupying "a long time." Taking advantage of the tide, as they certainly would have, a few hours would have been sufficient.

Attempts to locate Streamfirth other than those considered have little to recommend them. They are usually too far from the probable cruising radius of the Norse explorers or present only isolated and superficial resemblances to the regions described by our authorities.

This introduces us to a general consideration of the southernmost stopping place of the Norse explorers, Wineland itself. It has been confounded frequently with the region of Streamfirth very largely because it was so confounded by the compilers of the Flat Island Book, but the distinction is clearly indicated in the Saga of Eric the Red. Thus we are told that Thorhall went from Streamfirth "in search of Wineland" while Karlsefni voyaged south for the same purpose. It is true that *after* Karlsefni's return to Streamfirth we read that they came upon five Skrellings, among whom were two boys whom they made captive and from whom they obtained information regarding their people, and that this episode begins with the words "when they sailed away from Wineland," but it has not been observed that the whole section is an interpolation and probably an attempt to elaborate the episode of the five Skrellings whom they met and murdered when they were on their way from Wineland to Streamfirth.

Adequate reasons have already been given, I believe, for rejecting Steensby's theory of the location of Wineland.

We are not given the distance from Streamfirth to Hop (Wineland) but are merely told that in order to reach it "they sailed for a long time." How long that might be was left to the imagination of the reader, and imaginations have been busy with it ever since. But we have seen that when (or if) they sailed from the entrance of the Strait of Belle Isle to Cape Whittle, a distance of about 225 miles, it took them, according to one narrative "a long time," and according to another 2 dœgr. The Wonder-strands, a somewhat longer stretch of coast according to our theory, were "long to sail by."

If Streamfirth was the Bay of Fundy or anywhere in that neighborhood, we would naturally look for Wineland in New England, and a time period of 2 dœgr, the period of passage mentioned in the Flat Island Book, might very well bring us there but the accuracy of the scource is not to be counted on and according to various authorities a dœgr might mean anything from 50 miles to 150 or 200. If Streamfirth was in the St. Lawrence estuary or Chaleur Bay the distance covered would be nearer 900 miles, and our 2 dœgr would not carry us farther than Northumberland Strait.

The early, widely accepted theory as to the location of Wineland, fathered by Rafn, placed it in Mount Hope Bay, R. I., on the very slender possibility that the word "Hop," applied by Karlsefni to the lake or lakelike expansion of the river where they set up their cabins, had somehow survived into modern times. Babcock (1913, p. 137) accepted this theory, but, as in the case of the Wonder-strands, had to suppose considerable geological change during the last 900 years in order to establish a resemblance between the Mount Hope Bay of today and the Hop described in the Sagas. Instead of a single entrance with offshore bars, there are two deep-water entrances into this bay, and instead of one river flowing into it, there are four. The U. S. Coast Pilot for this section (U. S. Coast and Geodetic Survey, U. S. Coast Pilot, 1927, pp. 91, 105) says:

> There are two approaches by water to this bay, one through Sakonnet River and the other through the Eastern Passage of Narragansett Bay. The former is little used [but "is good for a depth of 20 feet (6.1 m.) to Mount Hope Bay, a distance of 12 miles"]; the latter [approach]. . . . has a depth of over 6 fathoms (11 m.) in the channel until in the bay.

Of the four rivers entering the bay, the principal is Taunton River.

Before continuing this discussion, however, it will be well to quote those passages from the narratives upon which we must depend for any attempted identifications. First, from the Saga of Eric the Red:

> It is now told of Karlsefni, that he cruised southward off the coast [from Streamfirth], with Snorri and Biarni, and their people. They sailed for a long

time, and until they came at last to a river, which flowed down from the land into a lake, and so into the sea. There were great bars at the mouth of the river, so that it could only be entered at the height of the flood-tide. Karlsefni and his men sailed into the mouth of the river, and called it there Hop [a small land-locked bay]. They found self-sown wheat fields on the land there, wherever there were hollows, and wherever there was hilly ground, there were vines. Every brook there was full of fish. They dug pits on the shore where the tide rose highest, and when the tide fell, there were halibut in the pits. There were great numbers of animals of all kinds in the woods. . . . No snow came there, and all of their live-stock lived by grazing.

The woods were near their dwellings as is proved by the fact that a bull frightened visiting natives away by running out of the woods, by the fact that one of the natives tested a Norse ax on a tree during the battle between the two parties, and by the fact that the Norse when attacked "fled into the forest."

When the Norsemen were put to flight by the Skrellings, they fled "up along the river bank" and "did not pause, until they came to certain jutting crags," giving us incidentally a topographic note.

After visiting the "land of the Unipeds" where Thorvald was killed, Karlsefni and his companions—

concluded that the mountains of Hop, and those which they had now found, formed one chain, and this appeared to be so because they were about an equal distance removed from Streamfirth, in either direction.

This seems to establish the existence of mountains in sight of Hop even if it was not in a mountainous country.

From the Flat Island Book we glean the following: After some details which evidently belong to the Streamfirth period confounded with the Wineland visit, it continues—

At ebb-tide there were broad reaches of shallow water there, and they ran their ship aground there, and it was a long distance from the ship to the ocean; yet were they so anxious to go ashore that they could not wait until the tide should rise under their ship, but hastened to the land, where a certain river flows out from a lake. As soon as the tide rose beneath their ship, however, they took the boat and rowed to the ship, which they conveyed up the river, and so into the lake, where they cast anchor and carried their hammocks ashore from the ship, and built themselves booths there. They afterwards determined to establish themselves there for the winter, and they accordingly built a large house. There was no lack of salmon there either in the river or in the lake, and larger salmon than they had ever seen before. The country thereabouts seemed to be possessed of such good qualities that cattle would need no fodder there during the winters. There was no frost there in the winters, and the grass withered but little. The days and nights there were of more nearly equal length than in Greenland or Iceland. On the shortest day of winter the sun was up between "eyktarstad" and "dagmalastad."

Grapes were soon discovered by the German Tyrker, and they returned to Greenland with a cargo of grapes, vines, and timber.

During Thorvald's supposed visit to Wineland a few men took the afterboat and explored the western coast the first summer.

They found it a fair, well-wooded country; it was but a short distance from the woods to the sea, and [there were] white sands, as well as great numbers of islands and shallows. They found neither dwelling of man nor lair of beast; but in one of the westerly isles, they found a wooden building for the shelter of grain. They found no other trace of human handiwork.

Thorvald also returned to Greenland with grapes and wood.

Karlsefni caused trees to be felled, and to be hewed into timbers, wherewith to load his ship, and the wood was placed upon a cliff to dry. They gathered somewhat of all of the valuable products of the land, grapes, and all kinds of game and fish, and other good things.

The Skrellings come through the woods, and the scene of battle was arranged by Karlsefni so as to have "the lake upon one side, and the forest upon the other." In preparation for this struggle 10 men were to show themselves upon "the cape." Karlsefni, like Leif and Thorvald, carries "vines and grapes" back to Greenland, but also peltries. Freydis carries "all the products of the land" back with her, but these are not enumerated.

In brief, at Hop was a lake with a river running through it or a lake-like expansion in a river, but it was so near the ocean that we do not know whether the water in it was salt or fresh. At the mouth of the river there were bars upon which the Norse vessels grounded at low tide, but at high tide they were able to pass over them into the lake. As we are told of the grounding only when our explorers first arrived, it is possible that there may have been a deeper channel which they missed. The region was thoroughly wooded. If the shelters erected there were not actually in the forest, the forest was close by, and some distance farther up the river, apparently not very far, was higher land described in the relations as "crags." From a later entry in the Saga it seems that there were mountains in sight.

If the account of that expedition "along the western coast" by Thorvald's men is to be relied upon, a similar coast, characterized by bars and sand islands, extended beyond Hop. To many writers this has suggested the southeastern shores of Massachusetts, and undoubtedly the southeastern coast of New England is one of those on which the narratives would lead us to look for Hop in spite of our rejection of Rafn's theory.

An inspection of the coast survey charts between Portland, Me., and New Haven, Conn., has yielded the following estuaries with inner expansions that might be regarded as lakes:

Scarboro River, Me., 5 feet over the bar at mean low tide; depth inside not given.

Hampton River, N. H., 3 feet over the bar; 20 feet inside.

Entrance of Merrimack River, Mass., 9 feet over the bar according to small-scale map, and 16½ on large-scale map, but the U. S. Coast Pilot says that the bar shifts and that the depth of water over it at mean low tide varies from 9 to 12 feet. The depth inside is 10-11 feet until one gets to Newburyport, when it is 12 to 18 feet.

Parker River and Plum Island Sound, Mass., 6 feet over the bar; 20 feet inside.

Essex River, Mass., 8 feet over the bar; 19 feet inside.

Barnstable Harbor, Mass., 5 feet over the bar; 19 feet inside.

Nauset Harbor, Mass., 6 feet over the bar; inside depth not given.

Chatham Harbor, Mass., 5 feet over the bar; 14 feet inside.

Mashpee River, Mass., 3 feet over the bar; 12 feet inside.

Slocums River, Mass., 2 feet over the bar; 7-8 feet inside.

The following information regarding these inlets is extracted from the U. S. Coast Pilot guide:

Spurwink and Scarboro Rivers, on the north side of the bight, can be entered only by small craft at half tide or higher with a smooth sea. They are seldom entered. [P. 211.]

Hampton Harbor, or Hampton River, a shallow stream used only by very small local craft, lies 1½ miles southwestward of Great Boars Head. The entrance is not safe for strangers. [P. 225.]

The entrance (of Newburyport Harbor, chart 331) is obstructed by a shifting bar, with 9 to 12 feet (2.7 to 3.7 m.) over it (according to the condition of the bar), which is dangerous to cross in heavy weather . . . . Jetties with an opening 1,000 feet wide between the ends have been built from both points at the entrance out to the bar. [P.225.]

Plum Island Sound (chart 1206) "is the approach to several small rivers and villages and is frequented by many small craft. Vessels seldom enter. It had a depth in 1926 of about 5 feet (1.5 m.) at low water across the bar."—Plum Island River "is bare at low water."—"Parker River, emptying into the north end of Plum Island Sound from westward, has a depth of about 5 feet (1.5 m.) in a very narrow channel to a fixed bridge at Newberry Old Town, 1¾ miles above the entrance. . . The river is navigable by small craft for several miles above Newberry Old Town, but is little used." [Pp. 228-229.]

Essex Bay and River (Chart 243) lie midway between Ipswich and Annisquam Lighthouses. The entrance is over a shifting bar, over which a depth of about 3 or 4 feet (0.9 to 1.2 m.) can be carried at low water through a narrow buoyed channel. The river is navigable to the town of Essex, 4 miles above its mouth, through a narrow dredged channel about 6 feet (1.8 m.) deep at low water. Vessels of 12-foot draft (3.7 m.), with local knowledge have been taken over the bar to an anchorage inside the entrance. [P. 229.]

Barnstable Harbor. . . . It is used by many local fishing boats but is seldom entered by strangers. The entrance is obstructed by a shifting bar with about 6 feet (1.8 m.) over it at low water. The Harbor is nearly filled by flats and shoals, which also extend 2 miles off the entrance from the shore eastward of the lighthouse. . . Few vessels enter the harbor, the greatest draft being 12 feet (3.7 m.). . . After crossing the bar the channel has a depth of about 8 feet (2.4 m.) for 3 miles to within $\frac{3}{8}$ mile of the wharf at Barnstable. [P. 293.]

Nauset Harbor. . . . The entrance is practically bare at low water and is used only by small local craft at high water. Strangers should never attempt to enter. [Atlantic Coast, Section B, Cape Cod to Sandy Hook, p. 35.]

Chatham Bar, the northern entrance to Chatham. . . The channel over the bar to the town of Chatham had a depth of about $3\frac{1}{2}$ feet (1.1 m.) at low water in 1925, but is subject to frequent changes, and the buoys at the entrance can not be depended on to lead in the best water. The channel is used only by small local craft with a smooth sea and is not safe for strangers. The large shoal bay northward of the entrance is seldom entered. [Ibid.]

Mashpee River is not mentioned in the Coast Pilot Guide, but Poponesset Bay into which it flows is said to be "used only by local oyster boats." The entrance is narrow and unmarked, dredged to 60 feet wide and 6 feet (1.8 m.) deep. The entrance channel is subject to shoaling, and in 1925 was good for a draft of only 3 feet (0.9 m). [Ibid.]

Slocums River is evidently of slight importance because the name does not appear either in the Coast Pilot Guide or on the Rand and McNally Map of Massachusetts.

Although each of these has what might be called a lakelike expansion just back from the sea, some of them, as for instance, Barnstable, Nauset, and Chatham Harbors, can hardly be said to have rivers flowing into or through them. Hampton, Parker, Essex, Mashpee, and Slocums Rivers are in tidal marshes and the expansions in them are due mainly to coastal bars or islands. The last two are in low, sandy country. The first 5 might perhaps be in sight of mountains, but of the 10 only the Merrimack seems to have the high land nearby called for in the relations. Newburyport, which is on the south bank, is on fairly high ground. Farther up, on the same side of the river, is a hill more than 40 feet high, and still farther up, opposite Carr Island, is one 120 feet high. This lies in a bend of the river. The channel into the Merrimack is given a maximum depth over the bar of $16\frac{1}{2}$ feet, as noted above, but this is modified by the statement of the Coast Pilot Guide and it is not indicated what it might have been before the jetties were constructed. The river enters the sea between two offshore beach islands, back of which and between them and the present Newburyport is a shallow expansion known as Joppa Flats. The mean high tide at the mouth of the river is 8 feet and at Newburyport 7.8 feet, and the lowest tide to be expected in either place is 3.5 feet. [P. 225.]

The above discussion shows that modern topography gives better warrant for locating Hop at the mouth of the Merrimack than in Mount Hope Bay with its two deep entrances and four rivers, or the shallow Back Bay. Nevertheless, I do not present the Merrimack as the site of Hop and the center of Wineland. The entrance seems to be too deep and the lakelike expansion too shallow, nor have I allowed for changes in the coast line due to the sinking of the land, changes produced by ocean currents, and so on. It is merely the best prospect that came out from an examination of coast charts. Further investigation might make the case for it stronger or weaker. For the present I would merely remark that it is as good as any other theory involving the New England coast.

A different region entirely was, however, suggested by Gustav Storm many years ago. This was Nova Scotia and, although the outer coasts of Nova Scotia do not have harbors suggestive of Hop, that is not the case with those in Northumberland Strait. Indeed, the southern shores of the Gulf of St. Lawrence in the provinces of Nova Scotia and New Brunswick, and the north shore of Prince Edward Island present features similar to those of southern New England and those indicated as surroundings of Hop.

On the northern coast of Prince Edward Island there are two principal entrances to consider, Malpeque Bay and Cascumpeque Bay, the former with 12 feet over the bar and 5-7 fathoms inside; the latter with 5 feet over the bar and 10 feet in Cascumpeque Harbor (U. S. Hydrographic Office, St. Lawrence Pilot, 1924, pp. 179 seq., and 183). The streams flowing into these, however, are hardly of the size called for, the mountains are wanting, and it is unlikely that navigators sailing south along the New Brunswick coast would have shifted their course to Prince Edward Island without mentioning the fact.

On the mainland from east to west we find the following inlets with their soundings as given in the St. Lawrence Pilot (pp. 83-128, 187-198):

Merigomish Harbor, N. S., 14 feet over the bar but with an intricate channel.

Pictou River, N. S., 19 feet over the bar at low water; inside 5-7 fathoms.

Pugwash Road, N. S., 6 feet over Lewis Bar; "Pugwash River, immediately within the harbor, extends into a small lake, $1\frac{1}{2}$ miles long and 1 mile broad, with $2\frac{1}{4}$ to 6 fathoms at low water."

Cocagne Harbor, N. B., 10 feet over the bar; $2\frac{1}{4}$ to 4 fathoms inside.

Buctouche River, N. B., 7 feet over the bar; inside channel wide with depth of 2-3 fathoms.

Miramichi Bay, N. B., 1 or 2 feet over the bar in most places but 22 feet in the ship channel which has been dredged.

Pictou Harbor would seem to be excluded from consideration on account of the depth of water at its entrance, but a case might be made out for any one of the others.

The argument as between New England and the Nova Scotia-New Brunswick coast must turn largely upon descriptions of the climate and the presence of grapes. In 1910 the botanist Fernald put forth a theory that the term in the Sagas translated grapes really referred to cranberries (*Vaccinium vitis-idæa*) or to a species of currant, and that the Norse did not get south of Labrador. His contention, however, was rather successfully countered 3 years later by A. L. Andrews and has not been accepted by most of the commentators on the Norse voyages (Fernald, 1910, pp. 17-38; Andrews, 1913, pp. 28-36). Whether there was anyone in Karlsefni's party who had ever seen grapes or not, I am satisfied that neither cranberries nor currants were mistaken for them.

Wild grapes are known to have been fairly plentiful in New England, and one species (*Vitis vulpina*) extended into the valley of St. John River, New Brunswick. Another (*Vitis novae-angliae*), the Pilgrim grape, reached as far north as the valley of Penobscot River, Me. Champlain (vol. 1, pp. 323-324) first encountered grapes on Richmond Island, Me., on July 9, 1606, and records the fact as follows:

Meantime the Sieur de Monts paid a visit to an island which is very beautiful on account of what it produces, having fine oaks and nut-trees, with cleared land and abundance of vines which in their season bear fine grapes. These were the first we had seen on any of these coasts from Cape Le Have [the point in Nova Scotia where they first landed and still bearing the name]. We named it the Island of Bacchus.

The same name was given by Cartier (Biggar, 1924, p. 126) to the Isle of Orleans below Quebec, the point farthest down the St. Lawrence where grapes grew, and one of the reasons why Steensby placed Wineland in that region.

On September 21, 1606, Champlain visited Richmond Island again and found the grapes ripe (vol. 1, p. 395):

At the Island of Bacchus, we saw grapes which were ripe and fairly good, and others which were not; they had a fruit as fine as those of France, and I am convinced that if they were cultivated one could make good wine from them.

Speaking of the same event, the historian Lescarbot (1911, vol. 2, p. 323) comments thus:

> At the entrance of the bay of the said district of Chouakoet is an island about half a league in circumference, on which our company made their first discovery of vines; for though they exist in places near to Port Royal, as, for example, along the St. John river, there was as yet no knowledge of them.

The Richmond Island vines are then described.

The French trader Denys, who lived in this region in the year 1645, gives testimony which is of the utmost importance. Speaking of the River St. John, particularly the lower section up to the head of navigation at the present Springhill, he says:

> There is found here also a great quantity of Wild Grapes, on wild vines which bear grapes, the fruit of which is large and of very good taste; but its skin is thick and hard. It comes to maturity, and if it were cultivated and transplanted I do not doubt that it would produce very good wine. This is a sign that the cold there is not so severe, nor the snows so abundant as everyone says.

To this the editor, W. F. Ganong, appends the following footnote (Denys, 1908, p. 120):

> The early English settlers on the Saint John are known to have made wine from the wild grapes, which are somewhat abundant along this river.

On the upper courses of three Nova Scotia rivers which Ganong identifies as the Allans, the Annapolis, and probably the Bear, Denys (p. 124) states that "the Grape-vine and the Butternut are also present," and he found the former on Pictou River which flows into Northumberland Strait. On this river he says (p. 190),

> there are Oaks, Beeches, Maples, Black Birches, Cedars, Pines, Firs and every other kind of woods. The large river is straight in the entrance; boats go seven or eight leagues up it after which there is met a little island covered with the same woods, and with grape vines, and above which one cannot go higher towards its source except with canoes.

Later he sums up his opinion of the grapes of the region and the possibility of making wine from them (p. 203):

> Let us see now whether the vine can come there to full maturity. In the first place it is certain that the country produces the vine naturally, that it bears a grape which matures to perfection, the grain being as large, perhaps, as the Muscadine. As to its juice, that is not so pleasing, since it is wild, and its skin is a little harder. But if it were transplanted and cultivated as is done in France, I do not doubt that its wine would be as good.

He planted vines on Miscou Island at the mouth of Chaleur Bay "which succeeded admirably." (P. 203.)

I know of no other references to grapes growing wild along the rivers flowing into Northumberland Strait, but if they were so "plentiful" on St. John River, one wonders if they might not at an earlier period have spread farther east in greater quantities than Denys indicates. Any idea that the climate may have altered materially is frowned upon by geologists and paleobotanists, but I do not understand that this inhibits the possibility of cyclar swings during which grapes might have spread farther east. Nor is it impossible that Indians in going to and fro along the trails from the St. John to the Gulf may have unintentionally spread grapes from one section to the other. There were several trails crossing the country in this way, one by Richibucto and Salmon Rivers to Grand Lake, and wild grapes have been found about the last mentioned in recent times. (Denys, p. 194.)

But without making such assumptions we may cite some evidence to the effect that the grapes in Wineland were not as plentiful as the narratives would indicate and that the explorers may have had to travel some distance inland to get them. If Leif came upon Wineland after crossing the entire North Atlantic as stated in the Saga, there is no certainty that his landfall was identical with that of Karlsefni, though it must have been well to the south. All that we learn from it is that specimens of grape vines were carried to Greenland by Leif. Nothing is said as to their abundance. This is indeed implied in one place in the narrative of Karlsefni in the words "wherever there was hilly ground, there were vines," but this party is not said to have carried grapes back to Greenland. Moreover, the two stories that have come down to us which profess to describe how grapes were discovered imply that they were at some distance from the place where the Norse had settled. The one included in the Saga attributes the find to two Scottish slaves who had been presented to Leif by King Olaf and loaned Karlsefni for this expedition. They were directed to run south and return by the end of the third half day which they did, bringing specimens of self-sown wheat and grapes. To be sure this episode is placed at Streamfirth, but it has long been recognized that it is an interpolation and it is generally held that it applies to the time when they reached Wineland proper. According to the story in the Flat Island Book, grapes were discovered by a German named Tyrker who had advanced farther into the country than his companions. The Flat Island Book is also mainly responsible for the supposed abundance of grapes. Excepting in the note above quoted there is no evidence for that in the Saga, and the specimen of grapes carried back by Leif is the only mention in it of any "cargo" of this fruit. It is possible that there is just enough truth in Nansen's myth theory to enable us to suppose that the "self-sown wheat" and grapes were noted because they fell in line with existing conceptions of the Islands of the Blest and what ought to be found there, and that may also have been why the name Wineland was applied to the country. The spirit of the reporter long antedated the newspaper.

In brief, it is possible that grapes were found only in the interior of the new country and did not occur in such quantities as we have been led to suppose.

That this south shore of the Gulf of St. Lawrence may have seemed to travelers from Greenland an earthly paradise is illustrated by the fact that a name of similar significance was given by Denys to one river flowing into the Gulf. He called it "the River of Cocagne," which, says his editor, "means . . . . a land of the greatest abundance, and has something of the significance of the English Utopia." But listen to Denys himself (pp. 192-193):

> I have named this river the River of Cocagne, because I found there so much with which to make good cheer during the eight days in which bad weather obliged me to remain there. All my people were so surfeited with game and fish that they wished no more, whether Wild Geese, Ducks, Teal, Plover, Snipe large and small, Pigeons, Hares, Partridges, young Partridges, Salmon, Trout, Mackerel, Smelt, Oysters, and other kinds of good fish. All that I can tell you of it is this, that our dogs lay beside the meat and the fish, so much were they satiated with it. The country there is as pleasing as is the good cheer.

The editor comments in a footnote (p. 192) that except for an error in distance (which does not appear in the part above quoted) Denys' description "is accurate and appreciative."

Another favored spot was Miramichi River. On the lower part of it were great quantities of strawberries and raspberries, great numbers of pigeons came there to feed, and salmon passing over the flats made such a noise that the explorers could not sleep. It is not surprising to be told, therefore, that it was a favorite resort of the Indians (p. 199).

What is said of Wineland weather is less favorable to the St. Lawrence region. The best authorities are agreed that the length of the day as given in the Flat Island Book would allow for an identification with any region up to 49° N. latitude. Therefore that item helps little. The same document goes to the absurd extreme of saying that there "was no frost in the winters, and the grass withered but little." Probably this is part of an attempt to so dress up Wineland as to make it appear a kind of earthly paradise. Both narratives affirm, however, that there was no snow, and we can hardly accept even that literally. At the same time it is a well-known fact that snowfall along the Atlantic coast is much lighter than that even a few miles inland, and remarkably open winters have been recorded at a number of points. Dr. Lewis cites the southern part of Nova Scotia and the Avalon Peninsula of Newfoundland as areas where one may look for a relatively mild winter climate. He informs me that the lowest temperature ever recorded at Yarmouth, Nova Scotia, is seven degrees below zero Fahrenheit and that only once, and adds:

On some of the Tusket Islands, off the coast of this county, and on islands off the coast of the next county, Shelburne, flocks of sheep are maintained the year around on open wild pasture, being obliged to depend entirely on their own foraging for their food and to live day and night, in fair weather or foul, without any fold, shed, or other artificial shelter. I can recall two different winters in which my father, when operating his farm on the mainland near Yarmouth, did all his plowing in the month of January, when the land was entirely free of both frost and snow.

Most of our cattle probably would not fare as well, but the stock of the Greenlanders, although housed during the winter, was no doubt accustomed to more severe weather conditions than the common run and might have stood proportionally more.

A summary of the arguments for and against a location of Wineland on the southern shore of the Gulf of St. Lawrence and the southern New England coast is now in order. Rivers with lakelike expansions corresponding sufficiently well to Hop and with offshore bars are present in both regions. Grapes grew plentifully in the latter area, and they formerly grew in parts of Nova Scotia and New Brunswick. The case for the St. Lawrence region depends on several factors—whether the Norsemen found grapes near their landing place or farther inland, and whether they were actually found in such quantities as the Flat Island Book and one expression in the Saga of Eric the Red would lead one to expect. Both regions have a winter climate rather more severe than the narratives indicate. There were parts of Nova Scotia in which winters were comparatively mild, but some of these must be excluded for topographic reasons, and it is doubtful whether similar conditions are ever matched along the south shore of Northumberland Strait. The Atlas of Canada, put out by the Canadian Department of the Interior in 1915, gives the average annual snowfall of southern New Brunswick, Prince Edward Island, and most of Nova Scotia as 60 to 90 inches (map 65), but it is evident that there is less in extreme cases. In southern New England the average number of days of snow cover during the year is between 30 on Cape Cod and along the southern coast to 90 in northeastern Massachusetts (Paullin and Wright, 1932, pl. 4). This item furnishes an argument for southern New England. In the matter of distance the northern location has the advantage. Our only clue to this is in the Saga where it is said that Karlsefni and his companions, after leaving Streamfirth, sailed southward "for a long time." The Flat Island Book which evidently confounds the Streamfirth episode with the Wineland experience would have it that they sailed from Markland for 2 dœgr, or but little more, before reaching it. If Streamfirth was the St. Lawrence estuary, and Wineland was along the southern shore of the Gulf, the distance covered was 200 to 300 miles, comparable to other distances which seem to have been covered in 2 dœgr, but if Wineland was on the coast of Massachusetts the time consumed would have been more than three times as great. If Streamfirth is identified with the Bay of Fundy, however, the distance between it and the southern location of Wineland would have been reduced to the figures above given. From this point of view the Bay of Fundy location of Streamfirth is the more probable if Wineland was in southern New England, but on the other hand it is less probable when the time needed to reach the Bay of Fundy around Newfoundland is considered. Another argument in favor of southern New England is supplied by the account of that expedition which, according to the Flat Island Book, Thorvald's men undertook from Hop "along the western coast." A coast consisting largely of "white sands, as well as great numbers of islands and shallows" suggests southeastern Massachusetts more than any other region.

One additional statement requires some consideration, particularly as it is given in the Saga of Eric the Red. After Karlsefni's voyage to the north, on which Thorvald died and on which they "believed they had got sight of the land of the Unipeds," ended, we read:

> They concluded that the mountains of Hop, and those which they had now found, formed one chain, and this appeared to be so because they were about an equal distance removed from Streamfirth, in either direction.

Juxtaposition of the three in this way has led several writers to place them near together geographically. Hermannsson, however, believes that the name Hop has been substituted for Streamfirth, and since he locates the latter in Chaleur Bay and the land of the Unipeds in the estuary of the St. Lawrence, he has no difficulty in identifying this range with the Shickshock Mountains of Gaspé Peninsula. The text, however, clearly designates *three*. Storm and Dieserud pack all these sites into Nova Scotia. But whatever may be said of the distance between Streamfirth and the land of the Unipeds, the former was much too far from Hop to be compressed into such a narrow space. Moreover, there is no reason why the voyagers should not have thought that the high lands they saw at these three places were connected even if the points of observation were far apart. It was another way of saying that they now believed they were on the shores of a continent, or at least one huge island, not in contact with a series of relatively small islands.

What is said of the inhabitants of America at this time, instead of casting light upon the places visited by Leif and Karlsefni, further mystifies us. Thus, according to the Saga of Eric the Red, the Skrellings, as they are called, arrived in skin boats, otherwise not known to have been used south of the Eskimo country except for the bull boats in the Missouri region, and they were armed with slings. As they came on they brandished "staves" and it is probable that these were spear throwers. Slings and spear throwers again suggest Eskimo rather than Indians, though this was far outside of the country known to have been occupied by the former. On the other hand, when Karlsefni went north from Streamfirth in search of Thorhall, his party encountered a Uniped who killed Thorvald with an arrow. The Flat Island Book, although it attributes Thorvald's death to an attack by a considerable body of Skrellings in canoes, confirms the fact that he was slain with an arrow and the attackers were seemingly all armed with arrows, no other weapon being mentioned. We have already raised the question whether it is possible that spear throwers were still being used in the south after bows and arrows had been adopted in the north, presumably by the Eskimo. Again, it is to be noted that, according to the Flat Island Book, the Skrellings of Hop issued out of the woods and did not come in canoes. Could it be possible that the Flat Island Book is correct in this particular, and that an attack in skin canoes which actually took place, as stated by this document, somewhere in the north has been transferred to the south by the writer of the Saga? So far as the final attack by the Skrellings is concerned, the Flat Island Book reflects Indian strategy better than the Saga. Instead of making a frontal attack, even if they had come in canoes, they would have landed at some point back of the town during the night and made an assault upon it early in the morning. The language of the Saga lends some support to the idea that this actually took place. If the Skrellings of Wineland used canoes, it is safe to infer that they were made of bark and not of skin. The Skrelling taste for red cloth is markedly

Indian, but we are puzzled to know why Karlsefni happened to have stocked his ship with it. He was, indeed, a trader, but he had had no previous experience of Indians or Eskimo. Perhaps, as one writer suggests, the sight of this red cloth roused the anger of the bull and so led to a rupture between Whites and Skrellings. Otherwise the explanation of this in the Flat Island Book to the effect that a Skrelling attempted to steal some weapon from a Norseman and was killed by him is the more probable. The writer of the Flat Island narrative has been ridiculed for speaking of the use of cows' milk in trade by the Norse, but this might have been a mere episode and not as extensive as represented, and the supplies of red cloth carried along by Karlsefni require explanation equally. The "wooden building for the shelter of grain" said to have been discovered by Thorvald's men in an island toward the west need occasion us less surprise—raised shelters of this kind being well known to the Indians—than their failure to find a single human being along coastlands which were densely occupied in later times.

It will be safe to discount the skin boats of the Hop Indians whatever we may think of those of the Unipeds, and to identify the Skrellings in that territory with the Indians, though we cannot tell whether they were the Algonquians later found in possession or not.

The "bomb" which occasioned such panic among the Norse has never been satisfactorily explained. The only suggestion made, so far as I am aware, is that of Schoolcraft, already mentioned. Unless it was some shaman's device to frighten the enemy, in which case it was eminently successful, I can suggest no explanation, and I doubt whether one ever will be suggested knowing as we do how many opportunities there were for the facts in the case to be distorted before an account was committed to writing. We may note, however, that it is given in the Saga of Eric the Red, and remark that if it had been incorporated in the narrative of the Flat Island Book it would have been regarded as another case of Flat Island Book romancing pure and simple.

The question of Norse relics need not be taken up here. The Dighton Rock, Skeleton in Armor, and old Stone Tower, in spite of a recent rehabilitation of the problem as concerns the last mentioned, may be safely rejected as valueless from the evidential point of view. The same cannot be said regarding certain more recent finds, including the Kensington Stone. But if Paul Knutson entered Minnesota and left this stone as a memorial of his visit, he came much later than Leif or Karlsefni and entered by way of Hudson Strait and Hudson

Bay. If he had previously visited and explored Wineland, we do not know where he actually went and what he called by that name. Most of the alleged Norse finds are in or near the St. Lawrence drainage area and if authenticated would merely confirm what we have independent reason to believe.[3]

SUMMARY OF CONCLUSIONS

A few general conclusions may now be ventured.

First, sound opinion identifies Helluland with Labrador, particularly the northern part. Exception is taken mainly by students who want to carry the Norsemen far to the south contrary to the probabilities, and are obliged to force an identification with Newfoundland.

The better scholarship is divided as to the location of Markland, one school holding it was Newfoundland though admitting that it possibly included southern Labrador, while the other believes that it was southern Labrador but possibly included northern Newfoundland.

This division of opinion is occasioned by the belief of one school that the Norse in voyaging south kept to the east of Newfoundland and the belief of another school that they entered the Gulf of St. Lawrence through the Strait of Belle Isle. The former seeks to find the Wonder-strands on the east shore of Cape Breton Island and Nova Scotia, Keelness at the northern end of the former, and Streamfirth either in the Bay of Fundy or some inlet on the outside coast of Nova Scotia toward its southern end. The other school identifies the Wonder-strands with the southern coast of Labrador and finds Streamfirth in the estuary of St. Lawrence River, Chaleur Bay, or some neighboring inlet, but is not agreed as to the location of Keelness.

There are also two theories which may be said to occupy premier positions regarding the location of Hop or Wineland. One places it in Nova Scotia or some territory immediately adjoining. The other identifies it with some point on the southern coast of New England.

For reasons already given, mainly the closer resemblance of conditions found along the south Labrador coast to the description of the Wonder-strands, I favor Steensby's theory on this point, identifying Helluland with northern Labrador, Markland with southern Labrador, and the Wonder-strands, as just stated, with part of the southern Labrador coast. I also agree with him in finding Streamfirth in the estuary of the River St. Lawrence, but differ entirely in

[3] This question has been very thoroughly covered by Holand (1940), but the authenticity of the Kensington Stone is still doubted by some.

the location of Wineland. As to the latter, the case for New England still seems a shade better, but there is no ground for dogmatic assertions either way.

The only original suggestions the writer has made himself are in locating Keelness at or near Cape Whittle, and in placing the land of the Unipeds and the scene of Thorvald's death in Hamilton Inlet or Sandwich Bay. My reference to the Merrimack River is hardly of the nature of a theory. The above seem to me conservative probabilities in the light of the very scanty traditions preserved to us in the Icelandic sagas.

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THE EDMONTON, KENTUCKY, METEORITE

(WITH FOUR PLATES)

BY
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AND
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The meteorite here described was presented to the United States National Museum by S. H. Perry, who obtained it in 1945 from H. R. Harper, of Beaumont, Ky. It had been plowed up in 1942 on the farm of Samp Johnson, 4 or 5 miles east of Edmonton, Metcalfe County, Ky., and is the twentieth meteorite found in that State.

The mass as received weighed 10,200 grams and was intact except for a small bit that had been removed from one end with a blowtorch, the local heating having left no visible effects on the microstructure of the first slice removed from that end. Its form was elongated and very irregular, the greatest length being about 24 cm.

This is obviously an old fall, as nothing remains of the original surface and there is considerable accumulation of brown iron oxide on most of the surface of the mass. Several irregularly shaped depressions occur on the surface of this iron, all of which appear to have been modified by weathering.

Microstructure.—Four slices were removed from the end of the mass, and etching revealed it as a finest octahedrite of great regularity and beauty, the width of the bands being very uniform at from 0.5 to 0.8 mm. Like the Carlton, Tex., iron[1] which it resembles, the Edmonton meteorite contains numerous large, irregular, elongated lamellae of kamacite from $1\frac{1}{2}$ to 2 mm. wide and up to 2 cm. long; these are unconformable with the octahedral pattern although roughly oriented in approximately parallel directions.

Although the analysis shows no sulfur and only traces of phosphorus (the sample analyzed being free from inclusions), a few irregular inclusions of troilite surrounded by swathing kamacite may be seen in plate 1, figure 1, as well as a few small schreibersite bodies. In one place a thin zone of schreibersite lies within the swathing kamacite surrounding a troilite inclusion.

The kamacite bands are bordered by tenuous lamellae of taenite.

[1] Howell, E. E., Amer. Journ. Sci., vol. 40, p. 223, 1890; Proc. Rochester Acad. Sci., vol. 1, pp. 87-89, 1890. In both references the Carlton iron is called Hamilton County.

Though in places the bands are closely grouped, plessite fields are relatively large and very abundant, and are mostly of the "dense" type consisting of imperfectly transformed gamma-alpha aggregate.

A few plessite fields show spheroidized taenite in a ground mass of clear kamacite, a feature that is being observed with increasing frequency as more meteoric irons are studied by metallographic methods. This structure appears to be due to a condition of cooling in which the taenite in the original gamma-alpha mixture was fully transformed but, because of too rapid cooling, could not migrate to the boundaries of the field to form the usual taenite border.

Near the edge of one of the slices there are traces of a zone of heat alteration, containing round bodies of an Fe-Fe_3P eutectic. These bodies, which have been observed in a number of other irons, are apparently due to the melting of schreibersite inclusions within the zone of alteration. Such fused inclusions, having absorbed iron (kamacite) from the surrounding mass, rejected the excess of the iron above the eutectic ratio in cooling, the excess separating as droplets or (as in this case) in the form of dendrites.

Composition of Edmonton iron.—A thin slice was cut and etched in order to develop the structures and make more conspicuous any inclusions or structural irregularities. A portion was selected which represented as nearly as possible the average pattern of the meteorite. Care was taken to exclude any visible inclusions from the sample used for the analysis. Meteorites are not homogeneous, and samples selected for analysis should not contain avoidable inclusions.

The chemical analysis reported represents a sample with average widmanstatten structures for this iron, and although the meteorite carries inclusions of troilite and schreibersite, no phosphides or sulfides apparently exist as disseminated small particles in the components which make up the average structure.

The following table shows analyses of the Edmonton, Ky., and the Carlton, Tex., irons. These two individuals have a very similar structural pattern and are also nearly identical in composition.

The specific gravity of the Edmonton iron was determined upon two different portions, both assumed to be free from inclusions. The gravity is only slightly lower than that reported by Eakins for the Carlton iron.

The radium determinations were made by Gordon L. Davis and William D. Urry, of the Geophysical Laboratory in Washington, D. C.

The molecular ratios for iron, nickel, and cobalt are obtained by dividing the percentage of each element found by the atomic weight of the element. The significance of these nickel, cobalt to iron, molec-

TABLE 1.—*Comparison of the Edmonton and Carlton irons*

	Edmonton, Ky. E. P. Henderson, analyst	Carlton, Tex. L. G. Eakins, analyst
Fe	86.61	86.54
Ni	12.57	12.77
Co	.79	.63
P	Trace	.16
S	None	.03
Insol	.009	.11
Sp. G	7.908	7.95
Sp. G	7.945	....
Ratio Fe	1.550	1.550
Ratio Ni	.214	.218
Ratio Co	.013	.010
Mol. ratio $\frac{Fe}{Ni + Co}$	6.82	6.79
Radium	$.046 \pm .001 \times 10^{-12}$ grams per gram	n.d.

ular ratios is uncertain, but they offer a convenient means of arranging analyses for comparison.

The following table contains all the meteorites now listed in the records of the United States National Museum as from Kentucky. Representative specimens of all these falls are in the Museum's collection.

TABLE 2.—*Kentucky meteorites*

Name	Type	Weight kg.	County	Latitude N.	Longitude W.
Bath Furnace	Chondrite	5.9	Bath	38°5′	83°45′
Campbellsville	Octahedrite	15.4	Taylor	37°21′	85°21′
Casey County	Octahedrite	.73	Casey	37°15′	85°
Clark County	Octahedrite	11.8	Clark	.....	.....
Cumberland Falls	Breccia	24.1	Whitley	36°46′	84°15′
Cynthiana	Chondrite	6	Harrison	38°23′	84°17′
Eagle Station	Pallasite	36.5	Carroll	38°38′	85°
Edmonton	Octahedrite	10.3	Metcalfe	37°	85°35′
Frankfort	Octahedrite	11	Franklin	38°8′	84°57′
Glasgow	Octahedrite	20.3	Barren	36°58′	85°55′
Kenton County	Octahedrite	163	Kenton	38°50′	84°30′
La Grange	Octahedrite	51	Oldham	38°25′	85°30′
Marshall County	Octahedrite	6.8	Marshall	36°50′	88°20′
Mount Vernon	Pallasite	159.2	Christian	36°55′	87°25′
Nelson County	Octahedrite	73	Nelson	37°50′	85°25′
Providence	Octahedrite	6.8	Trimble	38°34′	85°12′
Salt River	Octahedrite	3.7	Bullitt	37°58′	85°38′
Scottsville	Hexahedrite	10	Allen	36°43′	86°6′
Smithland	Ataxite	5	Livingston	37°10′	88°28′
Williamstown	Octahedrite	31	Grant	38°38′	84°31′

EXPLANATION OF PLATES

PLATE 1

FIG. 1. Slice, macro etch, $\times$ 4/5.

FIG. 2. Portions of two kamacite bands, one horizontal, two vertical with plessite in a variety of forms. The fields at left and upper right show a dense gamma-alpha aggregate surrounded by borders of clear fully transformed taenite. The narrow field or lamella in the center, separating the vertical bands, is mostly clear taenite. In its upper portion the structure is in part lamellar; three dark areas show oriented needles (lamellae) of the gamma-alpha mixture. A rounded area of kamacite is enclosed near the top, and lower an oval of kamacite with Neumann lines. In the center of the right-hand kamacite band is a lamella of taenite gray or black by reason of supersaturation with respect to kamacite. Picral 30 seconds, $\times$ 60.

PLATE 2

FIG. 1. Core of imperfectly transformed gamma-alpha aggregate in the center of a triangular taenite body. The acicular structure shows some orientation. Picral 15 seconds, $\times$ 400.

FIG. 2. Edge of a plessite field. The taenite along the interface shows no grayness, but is perfectly transformed. The specks and particles in the kamacite (above) are probably taenite, showing black because of the strong attack of the etchant along their interface. Picral 15 seconds, $\times$ 400.

PLATE 3

FIG. 1. A taenite lamella, with core of dark, acicular gamma-alpha aggregate oriented in conformity with the general octahedral pattern. Picral 15 seconds, $\times$ 400.

FIG. 2. Part of a plessite field. At upper right, a confused structure of gray supersaturated taenite in a dark gamma-alpha aggregate, and kamacite in lamellae and irregular particles. At lower left, imperfectly spheroidized taenite. Between the two areas there has been some invasion of hydroxide. Picral 15 seconds, $\times$ 400.

PLATE 4

FIG. 1. Part of the upper right portion of plate 3, fig. 2. The nature of the structure is more evident. Picral 15 seconds, $\times$ 400.

FIG. 2. An area in a zone of alteration. From upper left to lower right; dense core of a plessite field; clear taenite border of a plessite field; kamacite; edge of slice. The kamacite shows a secondary granulation caused by superficial heating in flight through the air, which also probably homogenized the gamma-alpha aggregate in the plessite field. In the kamacite area three original schreibersite inclusions have been altered into an Fe-Fe_3P eutectic. These eutectic areas show clear borders of phosphide, the excess of dissolved iron (kamacite) having been able to migrate to the surrounding mass instead of being entrapped to form dendrites. Picral 15 seconds, $\times$ 400.

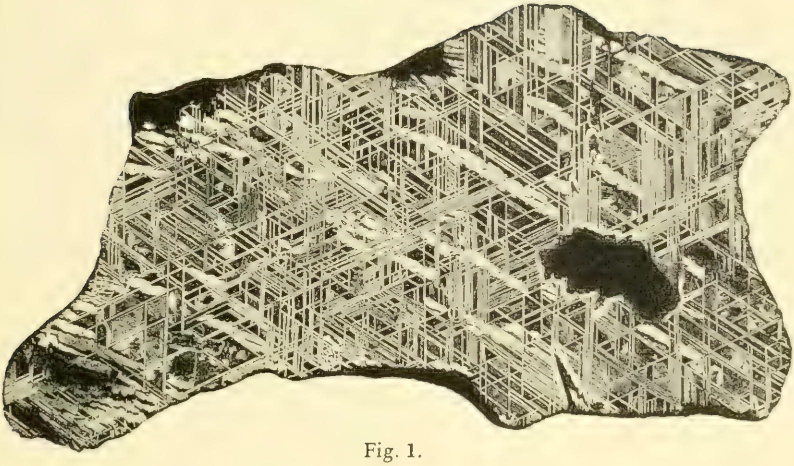

Fig. 1.

Fig. 2.
(See explanation of plates.)

THE EDMONTON, KENTUCKY, METEORITE

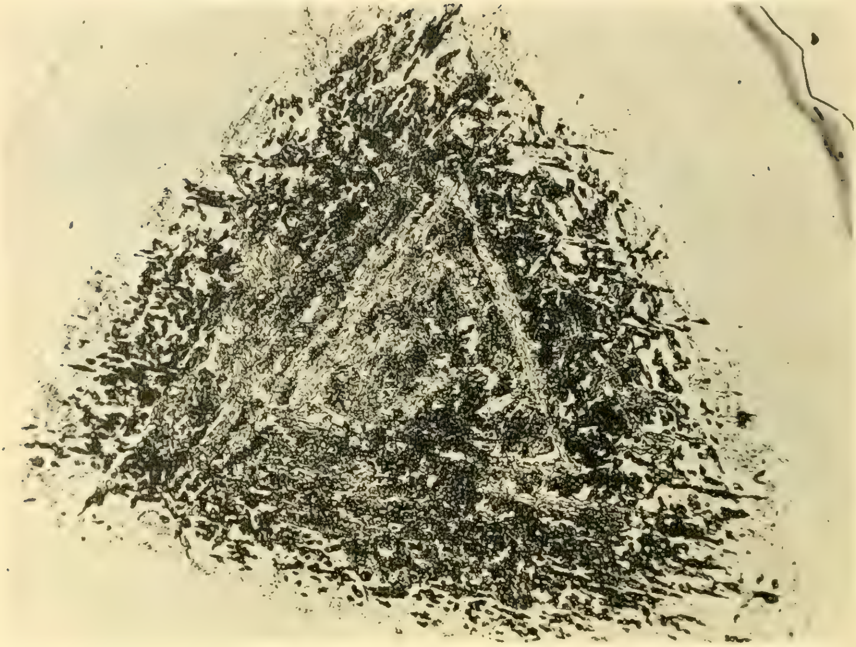

Fig. 1.

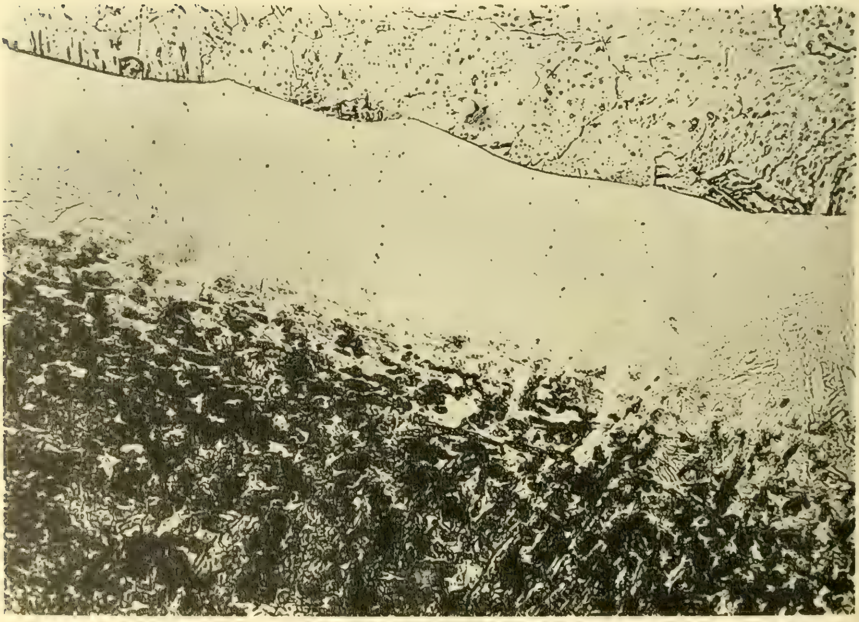

Fig. 2.
(See explanation of plates.)

THE EDMONTON, KENTUCKY, METEORITE

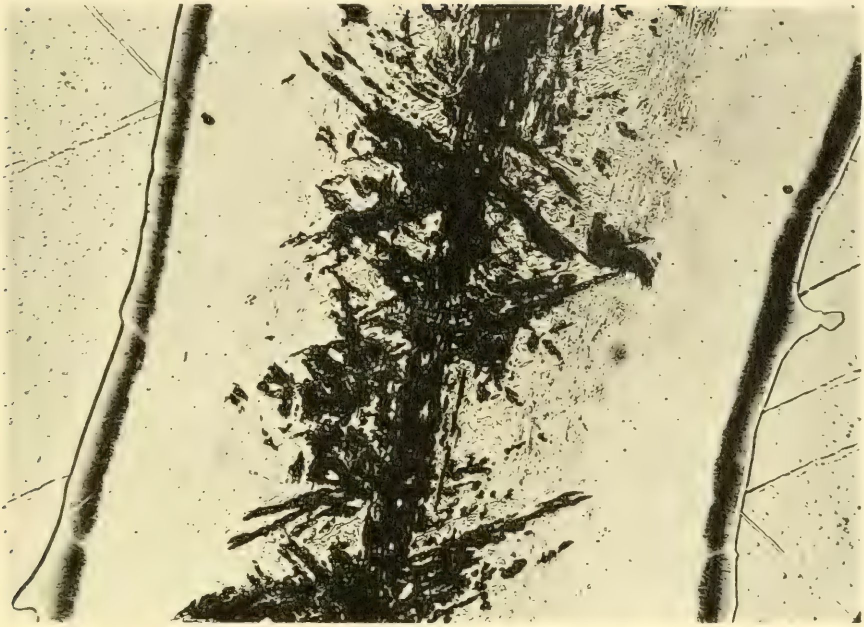

Fig. 1.

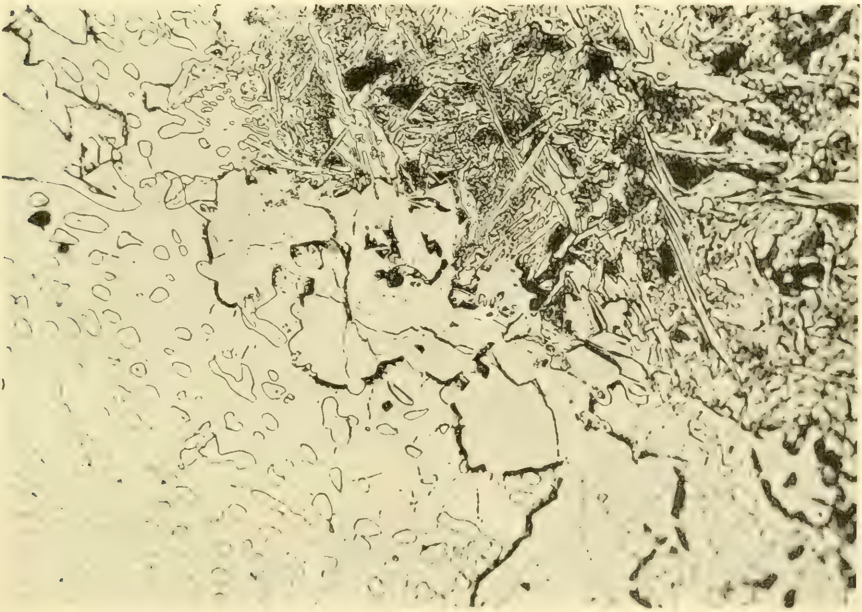

Fig. 2.
(See explanation of plates.)

THE EDMONTON, KENTUCKY, METEORITE

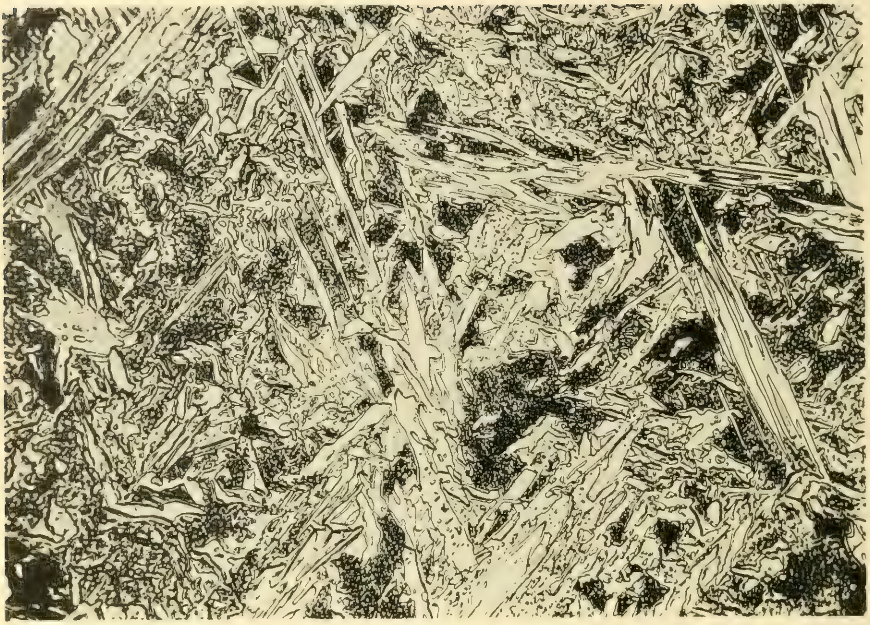

Fig. 1.

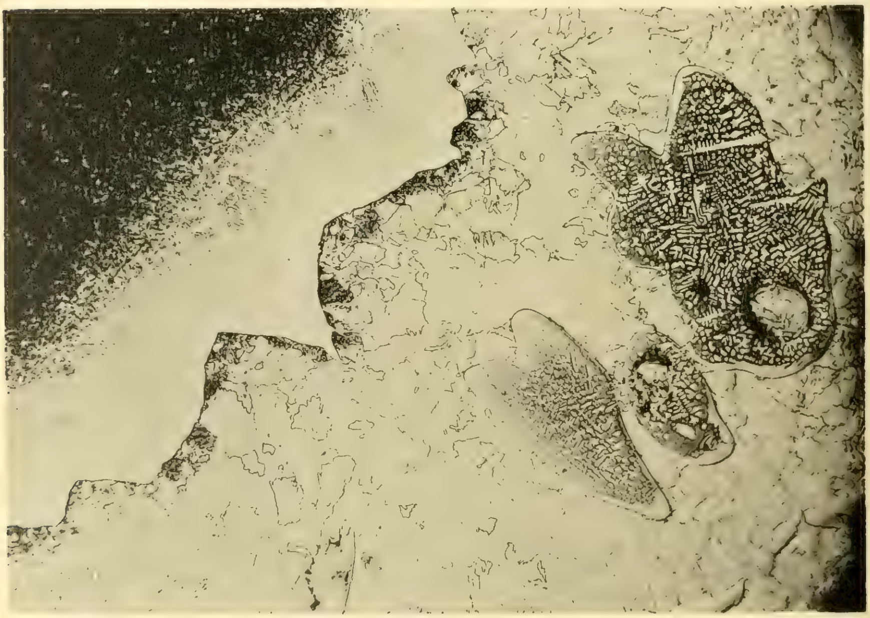

Fig. 2.
(See explanation of plates.)

THE EDMONTON, KENTUCKY, METEORITE

SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 107, NUMBER 14

A REVIEW OF THE RACES OF THE SPOTTED BABBLING THRUSH, PELLORNEUM RUFICEPS SWAINSON

BY
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A REVIEW OF THE RACES OF THE SPOTTED BABBLING THRUSH, PELLORNEUM RUFICEPS SWAINSON

By H. G. DEIGNAN

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Having long been dissatisfied with the conventional treatments of the well-known spotted babbling thrush, *Pellorneum ruficeps* Swainson, I have recently brought together a series of 339 specimens, possibly the greatest aggregation of this species that has ever been studied. The institutions that have cooperated in the project, and to the authorities of which my thanks are hereby rendered, are

1. Museum of Comparative Zoölogy, Cambridge, Mass. (M.C.Z.)
2. American Museum of Natural History, New York, N. Y. (A.M.N.H.)
3. Academy of Natural Sciences, Philadelphia, Penn. (A.N.S.P.)
4. United States National Museum, Washington, D. C. (U.S.N.M.)
5. Museum of Zoology, University of Michigan, Ann Arbor, Mich. (U.M.M.Z.)
6. Chicago Natural History Museum, Chicago, Ill. (C.N.H.M.)
7. Los Angeles County Museum of History, Science and Art, Los Angeles, Calif. (L.A.C.M.)

As might be expected in a terrestrial, sedentary bird of extensive range, considerable geographic variation appears in this material, and much of what has always been treated as simple individual variation proves to be of subspecific importance. Subspeciation is found not only in the major zoogeographic areas where, by analogy with other species, it might be expected to occur, but also within comparatively small portions of those areas, and trenchantly different forms are often separated from each other by rivers and hill ranges that to most other lowland birds of the Oriental Region would prove no barrier at all. The number of populations that have seemed to me worthy of nomenclatorial recognition will be received with complete disbelief, unless the importance of these delimiting geographic factors is realized. Acceptance of it, however, will at once explain such an anomaly as the supposed coexistence of *"Pellorneum ruficeps pectorale"* and *"P. r. minus"* in central Burma and the Chin Hills (see Smythies, Birds of Burma, 1940, pp. 502-503) or the statement that *"P. r. minus"* occurs throughout the range of *"P. r. mandellii"* and is also met with in the area occupied by *"P. r. subochraceum"* (see Stuart Baker, Fauna of British India, Birds, ed. 2, vol. 1, 1922, p. 242).

The fact is that in too many cases the type locality of the named forms has not been sufficiently restricted, with the result that series placed by the revisers under a single name have been composites of two or more distinct races. With proper arrangement, it will be seen that no two subspecies can be truly said to occur together and that, accordingly, there can be no question of two specific entities' having been confounded.

Geographic variation is shown mainly by the presence or absence of dark centers to the feathers of the uppermost back (present in all races north of about lat. 20° N., obsolescent in borderline populations, and absent in the more southern groups); color tone of the upper parts; the width and abundance of dark centers to the feathers of the breast and sides of the abdomen; the amount of buffy wash over the under parts.

What may be considered, from the broad view, individual variation, appears in the dimensions of bill, wing, and tail (to such an extent that in most races these measurements are without significance) and, within fairly narrow limits, in the several characters that serve as subspecific criteria. But when a long series of a given race is broken up in accordance with the various proveniences, it will be found that much of the so-called individual variation is in reality of a subracial nature. Variation of this sort is too tenuous to be worthy of a name, but is nevertheless of the greatest interest as a reflection of the extraordinary plasticity of the species.

Real individual variation is shown by a tendency to erythrism that appears in any race; specimens exhibiting this would seem to be "foxed," if others of the same place and date did not fail to show any deviation from the average coloration of much more recently collected birds. This rufescence is usual in immature examples and is stronger in the young of those populations in which increased rufescence has become a subspecific character. Worn plumage tends to become grayer, but the degree of wear varies so much from one specimen to another, without regard to the time of year, that I have not found it practical to divide my series on a seasonal basis.

Although a great number of skins have been available to me from the Indo-Chinese countries, it will be noticed that my material from India has not been equivalent; the Indian forms are nevertheless discussed, since certain changes in the accepted nomenclature are required by the rules of priority.

1. PELLORNEUM RUFICEPS OLIVACEUM Jerdon

P [*ellorneum*]. *olivaceum?* JERDON, Madras Journ. Lit. and Sci., vol. 10, "Oct." 1839, p. 255 ("jungles of Trichoor, Wurguncherry and Manantoddy"; type locality here restricted to Trichur, Cochin State, southwestern India).

Pellorneum ruficeps granti HARINGTON, Bull. Brit. Orn. Club, vol. 33, Dec. 23, 1913, p. 81 (Mynall, Trivandrum District, Travancore State, southwestern India).

Diagnosis.—No specimen has been examined, but *granti* was distinguished by Harington from *ruficeps* as "an altogether much darker and more richly coloured form."

Range.—Southwestern India (Travancore and Cochin States).

Remarks.—*Pellorneum olivaceum* was placed in synonymy with *ruficeps* by Jerdon himself (Birds of India, vol. 2, pt. 1, 1863, p. 27) and has been left there ever since. The type specimens came, however, from Trichur (lat. 10°31′ N., long. 76°14′ E.) and Wadakkancheri (lat. 10°40′ N., long. 76°15′ E.) in Cochin State and from Manantawadi (lat. 11°48′ N., long. 76°01′ E.) in the Malabar District of the Madras Presidency; in Cochin only the richly colored form of Travancore occurs (see Whistler, *in* Ali, Journ. Bombay Nat. Hist. Soc., vol. 38, 1935, pp. 78-79), while in Malabar some specimens are intermediate between *ruficeps* and the Travancore race (see Whistler and Kinnear, Journ. Bombay Nat. Hist. Soc., vol. 35, 1932, p. 747). To avoid fixation of the name upon an unstable population dwelling within a stone's throw of the type locality of *ruficeps,* the type locality of *olivaceum* must be restricted to one of the Cochin proveniences, and I have selected Trichur as the one farthest from the range of true *ruficeps.*

2. PELLORNEUM RUFICEPS RUFICEPS Swainson

Pellorneum ruficeps SWAINSON, Fauna Boreali-Americana, pt. 2, The Birds, Appendix No. 1, Feb. 1832, p. 487 (India; type specimen probably the one from the Nilgiri Hills, *ex* Gould Collection, recorded by Bowdler Sharpe, Catalogue of the Birds in the British Museum, vol. 7, 1883, p. 521; type locality here restricted to Coonoor, Nilgiri Hills District, Madras Presidency, India).

Megalurus? ruficeps SYKES, Proc. Comm. Sci. Corr. Zool. Soc. London, pt. 2, July 31, 1832, p. 91 ("the Dukhun"; type specimen probably the one from "? Mahabaleshwur hills," *ex* India Museum, recorded by Bowdler Sharpe, Catalogue of the Birds in the British Museum, vol. 7, 1883, p. 521).

M [*otacilla*]. *Dumeticola* TICKELL, Journ. Asiat. Soc. Bengal, vol. 2, Nov. 1833, p. 576 ("jungles of Borabhúm and Dholbhúm" =Manbhum and Singhbhum Districts, Chota Nagpur Division, Province of Bihar and Orissa, India.)

Diagnosis.—Specimens from the restricted type locality have the forehead, crown, and nape dull rufescent brown, some of the frontal feathers narrowly tipped with blackish; the remaining upper parts, including the exposed portions of the remiges and rectrices, olivaceous brown, the feathers of the mantle almost invisibly fringed paler and with pale shaft streaks, the tail feathers narrowly tipped with white; the lores and a posteriorly broadening supercilium extending to the nape, pale buff; the ear coverts brownish buff, often outlined posteriorly with dark brown; the feathers of the sides of the neck olivaceous brown, fringed with buff or buffy gray; the under parts white or buffy white, but heavily washed on the lower flanks with olivaceous brown, and with the feathers of the breast and sides of the abdomen bearing olivaceous-brown central streaks; the under wing coverts pale buff; the under tail coverts olivaceous brown, fringed with white.

Range.—According to Whistler and Kinnear (Journ. Bombay Nat. Hist. Soc., vol. 35, 1932, p. 746), the hills and coastal lowlands of western India from the Narbada River to Malabar; the Nilgiri Hills; the Eastern Ghats and adjacent lowlands from Coimbatore to North Arcot; Vizagapatam; isolated hill tracts in Orissa, Bihar, and western Bengal.

Specimens examined.—"SOUTH INDIA": no definite locality (2 unsexed), "Hundgi" (1 male, 1 female); MADRAS: Nilgiri Hills District: Coonoor (2 females); Bellary District: Bellary (1 female); BOMBAY: Poona District: Khandala (1 female); Rajpipla State: Juna (1 male); Kathiawar Peninsula: Songadh (1 female), Wadala (2 unsexed).

Remarks.—Under *P. r. ruficeps* British ornithologists have placed the birds of all India south of the Himalayas (excepting those of Travancore and Cochin). After seeing the populational variation exhibited by this species in the countries to the eastward, I find it difficult to believe that careful study of good series will not show that in India also considerable subspeciation occurs, especially in the isolated populations to the northeast. Tentatively, however, I accept their judgment.

The belief that the London example from the Nilgiris may be Swainson's type is based upon the fact that many, if not all, of the specimens listed by Swainson in the Fauna Boreali-Americana came later into Gould's possession; a number of the North American forms, including several types, were presented by Gould in 1857 to the Smithsonian Institution.

3. PELLORNEUM RUFICEPS PUNCTATUM (Gould)

Cinclidia punctata Gould, Proc. Zool. Soc. London, pt. 5, Dec. 5, 1838, p. 137 ("the Himalaya Mountains"; type locality here restricted to Kalka, Baghat State, Simla Hill States, India).

Pellorneum ruficeps jonesi Stuart Baker, Bull. Brit. Orn. Club, vol. 41, Nov. 9, 1920, p. 9 (Kalka, Baghat State, Simla Hill States, India).

Diagnosis.—Similar to *P. r. ruficeps,* but with a grayish cast to the rufous of the forehead, crown, and nape, and to the olivaceous brown of the remaining upper parts; the feathers of the sides of the neck and of the uppermost back fringed with buffy white or pale gray, those of the uppermost back also with ill-defined deep brown centers; the under parts more strongly washed with buff and with the central streaks of the feathers of the breast and sides of the abdomen narrower and of a much deeper color (blackish brown rather than olivaceous brown).

Range.—Western Himalayas from the Kangra District of the Punjab to Garhwal State.

Specimens examined.—Punjab: Kangra District: Bhadwar (7 males, 2 females).

Remarks.—The name *punctatum* was given to a bird from "the Himalaya Mountains," and nothing in his diagnosis indicates whether Gould was naming the race of the eastern or western hills. According to Hume, however (Stray Feathers, vol. 9, 1880, p. 251), the collection of which the specimen formed part was made "somewhere near Simla." It may be assumed that Hume had some good grounds for his statement, and I am the more willing to accept it since the name *mandellii,* dating from 1871, may then be left undisturbed for the bird of the eastern Himalayas.

Stuart Baker's *jonesi* was based upon two specimens, compared only with *mandellii.* His description is very misleading, for, in relation to *mandellii,* the black markings of the nape are *not* "even more highly developed," the black stipplings on the forehead are *not* "more numerous and highly developed," and the spots on the breast are *not* "much darker than in the average specimen of *mandellii*"*!* These discrepancies are, however, of only academic importance, since *jonesi* must be synonymized with *punctatum.*

4. PELLORNEUM RUFICEPS MANDELLII Blanford

Hemipteron nipalense Hodgson, *in* J. E. Gray, Zoological Miscellany, No. 3, 1844, p. 83 (Nepal). *Nomen nudum!* Synonymized with *Pellorneum mandellii* Blanford, by Godwin-Austen, Journ. Asiat. Soc. Bengal, vol. 46, pt. 2, No. 1, May 12, 1877, p. 41.

Pellorneum Mandellii Blanford, Proc. Asiat. Soc. Bengal for 1871, No. 9, Sept. 1871, p. 216 (Sikkim).

Pellorneum Mandellii Blanford, Journ. Asiat. Soc. Bengal, vol. 41, pt. 2, No. 2, June 25, 1872, p. 165, pl. 7, fig. 2 (Sikkim).

Pellorneum nipalense Bowdler Sharpe, Catalogue of the Birds in the British Museum, vol. 7, 1883, p. 518 (Nepal, *ex* Hodgson).

Diagnosis.—Similar to *P. r. punctatum,* but with the rufous of the front, crown, and nape deeper and richer in color and with the remaining upper parts rufescent brown (not grayish olivaceous brown); the centers of the feathers of the uppermost back blackish brown and more clearly defined from the light-colored fringes; the central streaks of the feathers of the breast and sides of the abdomen broader and bolder.

From *P. r. ruficeps* distinguishable by the more rufescent tones of the colors of the upper parts; by the bold dark central streaks of the feathers of the uppermost back; by the deeper color of the streaks of the breast and sides of the abdomen.

Range.—Nepal; Sikkim; Darjiling District.

Specimens examined.—"Himalayas": no definite locality (1 unsexed); Nepal: no definite locality (1 unsexed); Sikkim: no definite locality (4 unsexed); Bengal: Darjiling District: Sivok (1 female), Darjiling (1 unsexed).

Remarks.—It should be noted that the name *mandellii* dates, not from June 1872, as generally quoted, but from September 1871, as indicated above.

5. PELLORNEUM RUFICEPS CHAMELUM, new subspecies

Type.—A.M.N.H. No. 588344, adult male, collected at Gunjong, Cachar District, Surma Valley and Hill Division, Assam Province, India, on November 2, 1895, by E. C. Stuart Baker (*ex* Rothschild Museum).

Diagnosis.—Similar to *P. r. mandellii* in having sharply defined blackish-brown centers to the feathers of the uppermost back, but differing in having the rufous of forehead, crown, and nape, and the brown of the remaining upper parts paler and grayer (these parts intermediate in tones between those of *punctatum* and *mandellii*).

Range.—Southwestern Assam (Khasi Hills).

Specimens examined.—ASSAM: Garo Hills District: Tura (1 male), Rangsakona (1 unsexed); Cachar District: Gunjong (1 male, 2 females), Mahu (1 male).

Remarks.—*Pellorneum intermedium* was said by Bowdler Sharpe to range "from Cachar to the neighbourhood of Thayetmyo"; as will be found explained under *P. r minus,* this name is best restricted to the population of Thayetmyo, and the quite different birds of northern Cachar may then safely be called as above.

6. PELLORNEUM RUFICEPS PECTORALE Godwin-Austen

Pellorneum pectoralis [*sic*] GODWIN-AUSTEN, Journ. Asiat. Soc. Bengal, vol. 46, pt. 2, No. 1, May 12, 1877, p. 41 (Sadiya, Sadiya Frontier Tract, Assam Province, India).

Diagnosis.—Similar to *P. r. mandellii* in having sharply defined blackish-brown centers to the feathers of the uppermost back, but differing in having the rufous of the front, crown, and nape much deeper in tone (rufous chestnut); the brown of the remaining upper parts decidedly darker; the under parts more heavily washed with a richer (sometimes almost rufescent) buff.

From *P. r. chamelum* immediately separable by its much more saturate coloration above and below.

Range.—Northeastern Assam (Sadiya Frontier Tract).

Specimens examined.—ASSAM: Sadiya Frontier Tract: Tezu (1 male, 1 female).

Remarks.—Inasmuch as a form different from *pectorale* occurs so near Sadiya as Dibrugarh and Margherita, it was of some importance to learn whether Godwin-Austen's type was taken literally at Sadiya and thus represented the dark population found north of the Brahmaputra. Dr. Dillon Ripley has kindly investigated the matter for me in London and writes that Ogle took the type and four others along the Brahmakund road east of Sadiya and that all are of the darker race.

7. PELLORNEUM RUFICEPS RIPLEYI, new subspecies

Type.—A.M.N.H. No. 588323, adult male, collected at Margherita, Lakhimpur District, Assam Province, India, on December 21, 1901, by H. N. Coltart (*ex* Rothschild Museum).

Diagnosis.—Similar to *P. r. mandellii* in having sharply defined blackish-brown centers to the feathers of the uppermost back, but differing in having the rufous of the front, crown, and nape slightly richer in tone; the brown of the remaining upper parts much more strongly rufescent; the under parts more heavily washed with a richer (sometimes almost rufescent) buff.

From *P. r. chamelum* immediately separable by its very much warmer coloration above and below.

From *P. r. pectorale* distinguished by the much paler, less chestnut, rufous of the front, crown, and nape, and by the much lighter brown of the remaining upper parts.

Range.—Northeastern Assam (Lakhimpur District south of the Brahmaputra River).

Specimens examined.—Assam: Lakhimpur District: Dibrugarh (1 male, 1 female), Margherita (11 males, 5 females).

Remarks.—This race is named for S. Dillon Ripley, who collected the specimens of *pectorale* that confirmed the distinctness of the Margherita population and who has sent me valuable information on the series of *Pellorneum ruficeps* in the British Museum.

8. PELLORNEUM RUFICEPS STAGERI, new subspecies

Type.—U.S.N.M. No. 377762, adult male, collected at N'Pon Village (on the left bank of the Irrawaddy, 15 miles north of Myitkyina), Myitkyina District, Sagaing Division, Burma, on May 17, 1945, by Kenneth E. Stager (original number B-176).

Diagnosis.—Similar to *P. r. mandellii* in having sharply defined blackish-brown centers to the feathers of the uppermost back, but differing in having the rufous of the forehead, crown, and nape deeper in color (almost chestnut); the olivaceous brown of the remaining upper parts somewhat darker; the central streaks of the feathers of the breast and sides of the abdomen broader and more numerous.

From *P. r. pectorale* distinguishable by having the front, crown, and nape chestnut rufous (rather than rufous chestnut); the brown of the remaining upper parts paler; the under parts even more boldly streaked and with the ground color (except in two individuals discussed below) palest buff.

From *P. r. ripleyi* separable by having the rufous of the front, crown, and nape darker (nearer to chestnut); the remaining upper parts darker and more olivaceous, less rufescent (thus more clearly demarcated from the color of the nape); the under parts even more boldly streaked and with the ground color (except in two individuals discussed below) palest buff.

Range.—Northeastern Burma (Myitkyina and Bhamo Districts).

Specimens examined.—Burma: Myitkyina District: N'Pon Village (1 male, 1 female), Tanga (1 male), Washaung-Namaoyang road (1 male), Lonkin (1 female); Bhamo District: Bhamo (2 females).

Remarks.—Two females (1 from N'Pon, 1 from Lonkin) must be considered "erythros" (a neologism constructed by analogy with "melano"). Although they are, especially above, less rufescent than examples of *ripleyi,* yet they approach them below in the amount of rich buffy wash and in having the streaks on the breast and sides of the abdomen brownish and therefore less clearly demarcated from the ground color than is the case with the other specimens of *stageri* (which have the streaks blackish and the ground color buffy white).

Differences between *stageri* and *"pectorale"* (=*ripleyi*) have already been commented upon by Mayr (Ibis, ser. 14, vol. 5, 1941, p. 69).

The new race is named for Kenneth E. Stager, Curator of Ornithology and Mammalogy at the Los Angeles County Museum of History, Science and Art, who collected the type specimen while serving as a member of the United States of America Typhus Commission.

9. PELLORNEUM RUFICEPS SHANENSE, new subspecies

Type.—A.M.N.H. No. 143416, adult female, collected at Ma-li-pa (lat. 23°41′ N., long. 98°46′ E.), Kokang State, Burmese Wa States, on March 15, 1917, by Roy C. Andrews and Edmund Heller (original number 567).

Diagnosis.—Differs from the five races immediately preceding by having obsolescent deep brown centers to the feathers of the uppermost back, much as in *P. r. punctatum.*

From *P. r. stageri,* the geographically nearest form, distinguished also by having the rufous of the front, crown, and nape somewhat paler and brighter; the brown of the remaining upper parts paler and rather more olivaceous; the central streaks of the feathers of the breast and sides of the abdomen much narrower and less numerous; the ground color of the under parts intermediate between the two extremes shown by the series of *stageri* (discussed above).

Range.—The parts of Burma and southwestern Yunnan lying between the Mekong and Salween Rivers.

Specimens examined.—YUNNAN: Southwest: Chaunglung (1 male); BURMA: Kokang State: Ma-li-pa (1 female); Kengtung State: Loi Mwe (1 female), Mong Len (2 unsexed).

Remarks.—The three specimens from Kengtung State have been discussed by Meyer de Schauensee (Proc. Acad. Nat. Sci. Philadelphia, vol. 98, 1946, pp. 114-115). It is highly noteworthy that a race quite distinct from *shanense* is found in the Siamese province of Chiang Rai, less than 30 miles distant from Mong Len, one of the localities for this new form.

10. PELLORNEUM RUFICEPS HILARUM, new subspecies

Type.—M.C.Z. No. 265793, adult female, collected at Kyundaw (lat. 21°01′ N., long. 94°35′ E.), Pakokku District, Magwe Division, Burma, on January 28, 1938, by Gerd Heinrich (original number 1274).

Diagnosis.—The feathers of the uppermost back have the dark brown centers even more obsolescent than is the case with *P. r. shanense.*

This race furthermore has the rufous of the front, crown, and nape paler and slightly more grayish than in *shanense* (near to the color of these parts in *chamelum*) ; the remaining upper parts grayish olivaceous brown (but little browner than are these parts in *punctatum*) ; the ground color of the under parts pale buff (slightly paler than in *shanense,* with which it agrees, however, in the breadth and abundance of the dark streaks on the breast and sides of the abdomen).

Range.—Central Burma (Mandalay, Meiktila, Pakokku, Lower Chindwin Districts, and southern part of Upper Chindwin District).

Specimens examined.—Burma: Mandalay District: Maymyo (1 male, 1 female) ; Meiktila District: "Kalaw" (1 unsexed) ; Pakokku District: Kyundaw (1 female), Dudaw Taung (1 male, 1 female) ; Lower Chindwin District: Taungbauk (1 male) ; Upper Chindwin District: Mingin (1 male, 1 female).

Remarks.—So far as one may judge from a single example, the bird collected at "Kalaw" belongs with this race. Kalaw lies just at the western edge of the Shan Plateau, above the plains of Meiktila, and one would hardly expect the population of the plateau to be outwardly identical with that of the lowland Dry Zone. Since the specimen has by no means as full data as one could wish, I have assumed that the locality is only roughly correct, and that the bird was collected somewhere near, but west of and below, Kalaw, and thus in the Meiktila District.

11. PELLORNEUM RUFICEPS VICTORIAE, new subspecies

Type.—A.M.N.H. No. 306134, adult male, collected on Mount Victoria (lat. 21°15′ N., long. 93°55′ E.), Kanpetlet District, Magwe Division, Burma, on March 12, 1938, by Gerd Heinrich (original number 2010).

Diagnosis.—Nearest *P. r. hilarum,* but with the rufous of the forehead, crown, and nape paler and grayer (close to the color of these parts in *punctatum*) ; the remaining upper parts olivaceous gray-brown (more gray and less brown than in any other race) ; the under parts streaked as in *hilarum,* but with the ground color an even paler buff.

Range.—Burma (Chin Hills).

Specimens examined.—BURMA: Kanpetlet District: Mount Victoria (1 male), Kyaukswe (1 male).

12. PELLORNEUM RUFICEPS subsp.

In Arakan there seems to be a distinct race, characterized by obsolescent dark centers to the feathers of the uppermost back and a warm rufescent suffusion above and below. Since but two old specimens have been seen, neither of which has proper data, and one of which is an "erythro," this population will not be named here, although, since it does not agree with any of the neighboring ones, a special designation will probably be found necessary in the future when better material is available.

13. PELLORNEUM RUFICEPS MINUS Hume

Pellorneum minor [*sic*] HUME, Stray Feathers, vol. 1, Nos. 2-4, Feb. 1873, p. 298 (Thayetmyo, Thayetmyo District, Magwe Division, Burma).

Pellorneum intermedium BOWDLER SHARPE, Catalogue of the Birds in the British Museum, vol. 7, 1883, p. 519, pl. 13, fig. 1 ("from Cachar to the neighbourhood of Thayetmyo"; type locality here restricted to Thayetmyo, Thayetmyo District, Magwe Division, Burma).

Diagnosis.—From all precedent forms, excepting *olivaceum* and *ruficeps,* distinguished by having no trace of dark centers to the feathers of the uppermost back and by having the light edgings to the feathers of the sides of the neck narrow and inconspicuous.

Pellorneum r. minus has the rufous of the forehead, crown, and nape brighter than has any race yet discussed; the remaining upper parts olivaceous brown, faintly suffused with rufescent; the under parts everywhere washed with buff and with the central streaks of the feathers of the breast and sides of the abdomen narrow and sparse.

Range.—Burma (valley of the lower Irrawaddy from the Thayetmyo District to its mouths).

Specimens examined.—BURMA: Thayetmyo District: Thayetmyo (1 male), Pyalo (1 male); Prome District: Shwedaung (1 female); Tharrawaddy District: Pinmezali Resthouse (1 female); Insein District: Insein (1 male); Rangoon Town District: Rangoon (2 males, 4 females).

Remarks.—Bowdler Sharpe based his *intermedium* upon two examples (one a juvenile) from Dilkhusha (a locality not shown on modern maps, but situated on the Barak River in the Cachar District of Assam) and an unknown number of specimens from Thayetmyo (borrowed from Wardlaw Ramsay). The description is unsatisfactory, and no type was designated, but the colored plate appears to have been taken from one of Ramsay's southern birds; certainly it is not like the form from the hills north of the Surma Valley that I have called *chamelum*. Whatever race is found at Dilkhusha cannot possibly be identical with that of Thayetmyo, and I adjudge it best to make Sharpe's name an absolute synonym of Hume's *minus* and thus to remove it from all further consideration.

14. PELLORNEUM RUFICEPS SUBOCHRACEUM Swinhoe

Pellorneum subochraceum SWINHOE, Ann. Mag. Nat. Hist., ser. 4, vol. 7, Apr. 1871, p. 257 ("the Tenasserim provinces": type locality here restricted to Moulmein, Amherst District, Tenasserim Division, Burma).

Diagnosis.—Similar to *P. r. minus*, but distinguished by having the brown of the upper parts paler and less olivaceous, more rufescent; the under parts washed with a more vivid buff.

Range.—Burma (Salween, Thaton, Amherst, Tavoy Districts, and mainland Mergui District).

Specimens examined.—BURMA: Salween District: Sinzwe Forest, Yunzalin River (1 male); Thaton *or* Amherst District: "Thaungyin Valley" (3 females); Amherst District: "Hteekleethoo Choung" (1 female), Mepale (1 male, 2 females), Kaukareik (1 male), Lampha (1 female); Mergui District: Bokpyin (2 males), Ban Sadein (1 female).

Remarks.—Although *P. r. subochraceum* is not a strongly marked form, yet it seems to be readily separable in series; it is in some respects transitional between *minus* and the following archipelagic race.

15. PELLORNEUM RUFICEPS INSULARUM, new subspecies

Type.—U.S.N.M. No. 180408, adult female, collected on Domel Island (lat. 11°37′ N., long. 98°16′ E.), Mergui Archipelago, Mergui

District, Tenasserim Division, Burma, on January 25, 1904, by William L. Abbott.

Diagnosis.—Similar to *P. r. subochraceum,* but trenchantly separated by having the rufous of front, crown, and nape deeper in tone (almost chestnut); the hue of the remaining upper parts darker and much more rufescent; the ground color of the under parts a richer, almost rufescent, buff.

Range.—Burma (Mergui Archipelago).

Specimens examined.—BURMA: Mergui District: Ross Island (1 male), Domel Island (1 female), Sullivan Island (1 male), Saint Matthew Island (1 male, 1 female).

Remarks.—*Macronous* (*"Mixornis"*) *gularis* is another babbling thrush that has evolved a distinct race on these islands; it must be called *M. g. archipelagicus* (Oberholser), 1922.

16. PELLORNEUM RUFICEPS ACRUM, new subspecies

Type.—U.S.N.M. No. 330563, adult male, collected at Yala (lat. 6°30′ N., long., 101°15′ E.), Yala Province, Siam, on January 30, 1931, by Hugh McC. Smith (original number 4512).

Diagnosis.—Similar to *P. r. subochraceum,* but distinguishable in series by having the rufous of the forehead, crown, and nape slightly deeper in tone; the brown of the remaining upper parts darker and colder (even more olivaceous and less rufescent than in *P. r. minus*); the under parts rather more lightly washed with a somewhat paler buff.

Range.—Southwestern Siam (from the headwaters of the Mae Klong) southward down the Malay Peninsula (excepting the Burmese portion) to Perak and Pahang.

Specimens examined.—MALAYA: Pahang: Gunong Tahan (1 male); Kelantan: Sungei Lebir (1 female); Perak: Taiping (1 male, 1 female); SIAM: lat. 6°-7° N.: Narathiwat (4 males), Yala (1 male), Bukit Pattani (1 male); lat. 7°-8° N.: Phatthalung (1 male), "Trang Province" (1 male, 1 female), Chong (1 male), Ban Phra Muang (1 male), Ban Tha Chin (1 male, 2 females), Ban Thap Thiang (1 female); lat. 8°-9° N.: Khao Phanom Bencha (2 males), Ban Krasom (1 male), Ban Khiri Wong (1 male), Nakhon Si Thammarat (2 females); lat. 9°-10° N.: Surat Thani (1 male); lat. 11°-12° N.: Khao Nok Wua (1 female), Khao Luang (4 males, 3 females), Prachuap Khiri Khan (4 males, 3 females); lat. 12°-13° N.: Khao Sam Roi Yot (3 males), Pran Buri (1 male), Ban Kaeng Sok (1 male, 1 female), Ban Thung Luang (6 males, 2 females);

lat. 13°-14° N.: Rat Buri (1 male), Ban Pong (2 males); lat. 14°-15° N.: Kanchanaburi (3 males), Ban Si Sawat (2 males, 1 female); lat. 15°-16° N.: 28 mi. E. of Ban Um Phang (1 female).

Remarks.—Beyond such a minor distinction, from one population to another, as a slightly more or less rich buffy wash on the under parts (and this appearing capriciously), it is not possible to find any character by which the rich material before me can be subdivided. That birds of this plastic species should be almost uniform across more than 11 degrees of latitude may be easily explained by the Malay Peninsula's lack of natural barriers to north-south expansion.

17. PELLORNEUM RUFICEPS subsp.

One specimen has been seen from Pulau Langkawi, the large island at the northern mouth of the Strait of Malacca just off the Malay State of Kedah. In the bold streaking beneath and the very light wash of buff, it differs strikingly from any one of the long series of *P. r. acrum* from the adjacent mainland, but can be separated from the race of northwestern Siam only by the rather deeper coloration of its upper parts. I believe that a distinct subspecies will be found to inhabit Langkawi and the neighboring Pulau Terutau.

18. PELLORNEUM RUFICEPS subsp.

Two specimens from southeastern Burma, one from Thandaung, the other from "Pegu Yomas," do not agree with any one of the several Burmese races already described. They have the upper parts as in the form of northwestern Siam and the under parts with equally bold streaks but on a ground color much like that of *P. r. minus*. They are perfectly distinct from this last and probably represent a subspecies confined to the valley of the Sittang.

19. PELLORNEUM RUFICEPS CHTHONIUM, new subspecies

Type.—U.S.N.M. No. 336631, adult female, collected at elevation 2,900 feet on Doi Suthep (lat. 18°50′ N., long. 98°55′ E.), Chiang Mai Province, northwestern Siam, on November 21, 1936, by H. G. Deignan (original number 1932).

Diagnosis.—Upper parts much as in *P. r. acrum*, but the feathers of the uppermost back frequently with vaguely nigrescent centers; the central streaks of the feathers of the breast and sides of the abdomen almost always broader and more numerous; the buffy wash of the under parts usually almost restricted to the flanks and breast (where it often forms a fairly distinct pectoral band), with the result that, in series, this is, despite the heavy streaking, a whiter bird beneath than any one of the seven precedent forms.

Range.—Hilly country of northern Siam (excepting Chiang Rai Province), on the west south to Ban Kaeng Soi (lat. 17°45′ N., long. 99°15′ E.) and probably farther, on the east south to Muang Lom Sak (lat. 16°45′ N., long. 101°10′ E.).

Specimens examined.—SIAM: North: Ban Kaeng Soi (1 female), Doi Ang Ka (1 unsexed), Doi Samoeng (2 males), Doi Suthep (2 females), Chiang Mai (4 males, 4 females), Ban Chiang Dao (1 female), Doi Chiang Dao (2 females), Ban Huai Chang Tai (1 male), Ban Tong Pa Sa (1 unsexed), Doi Nang Kaeo (1 male, 4 females), Doi Khun Tan (3 males, 1 female), Ban Mae Mo (1 male, 1 female), Ban Mae Phun (1 male), Ban Phai Thon (1 female), Muang Ngop (1 male), Ban Nam Khian (1 female), Doi Ta Kong (1 male), Muang Lom Sak (9 males, 2 females).

Remarks.—Unlike many other northern Siamese species, *Pellorneum ruficeps* shows no important differentiation to east and west of the Khun Tan Range. Since *P. r. chthonium* everywhere ascends the hills to the lower limit of the evergreen forest, it is plain that several of the passes through these mountains could serve as funnels for its distribution across them.

On Doi Suthep it ranges unchanged from the plains at its foot to about 3,000 feet, where the mountain evergreen begins. An apparently isolated colony exists in the open hill forest of oak and pine from 4,500 to 5,000 feet; unfortunately, no specimens of this population have been available for comparison with the lowland birds.

N.B.—An aggregation of 19 examples from the lower Pa Sak River (Ban Thawai Phra, Ban Manao Wan, Ban Kaeng Khoi), the hills dividing the Chao Phaya system from that of the Mekong (Ban Pak Chong, Ban Lat Bua Khao), the western part of the plateau of eastern Siam (Ban Bua Yai), and the country between this plateau and "Southeastern Siam" (Kabin Buri, Ban Aranyaprathet) cannot be placed to subspecies at the present time. While all the localities named lie near each other on the map, a peripheral line connecting them would include just the territory where two, if not three, races might be expected to intergrade. It is possible that the birds of the lower Pa Sak must be identified eventually as atypical *chthonium,* those of Kabin Buri and Ban Aranyaprathet as atypical examples of the form of "Southeastern Siam," those of Ban Pak Chong and Ban Lat Bua Khao as intermediate between *chthonium* and a hypothetical race of the eastern plateau (which would be exemplified by the single specimen from Ban Bua Yai). In short, unless one is to risk naming a population variably intermediate between two other races, no step in this direction should be taken until much more material from the center of the eastern plateau has been carefully examined.

20. PELLORNEUM RUFICEPS INDISTINCTUM, new subspecies

Type.—U.S.N.M. No. 336635, adult male, collected at Chiang Saen Kao (lat. 20°15′ N., long. 100°05′ E.), Chiang Rai Province, northernmost Siam, on January 12, 1937, by H. G. Deignan (original number 2188).

Diagnosis.—Similar to *P. r. chthonium,* but distinguishable in series by having the rufous of the forehead, crown, and nape a little paler in tone; the color of the remaining upper parts paler and decidedly more rufescent; the under parts slightly more strongly washed with a rather warmer buff.

From *P. r. shanense* (which occurs in the adjacent Southern Shan State of Kengtung) easily separable by having the general coloration of the upper parts paler in tone; the light edgings to the feathers of the sides of the neck narrow and inconspicuous; the dark centers to the feathers of the uppermost back almost invisible or wholly absent; the under parts less extensively washed with buff—the throat almost free of this color.

Range.—Northern Siam (Chiang Rai Province); probably the part of Haut-Laos lying west of the Mekong River.

Specimens examined.—Siam: Chiang Rai Province: Chiang Saen Kao (2 males), Chiang Rai (1 male), Muang Fang (3 males), Ban Muang Sum (1 female), Ban Tao Pun (1 female), Ban Pang Ai (1 male), Doi Khrang (2 males, 1 female), Wiang Pa Pao (1 male, 1 female); Laos: Enclave: Doi Chang Kong (1 juvenile male).

Remarks.—*P. r. indistinctum* is but one of several birds that occur in northern Siam only within the Mekong drainage.

21. PELLORNEUM RUFICEPS OREUM, new subspecies

Type.—C.N.H.M. No. 78973, adult male, collected at Muong Moun (lat. 21°42′ N., long. 103°21′ E.), Laichau Province, northwestern Tongking, on March 29, 1929, by J. Van Tyne (original number 919).

Diagnosis.—Distinguished from *P. r. indistinctum* by having the rufous of the front, crown, and nape and the rufescent brown of the remaining upper parts decidedly deeper in tone; the dark centers to the feathers of the uppermost back more frequently present and rather more sharply defined; the light edgings to the feathers of the sides of the neck broader and more conspicuous; the under parts rather less extensively washed with buff.

From *P. r. shanense* separable by having the brown of the upper parts slightly more rufescent, less olivaceous; the dark centers to the feathers of the uppermost back less strongly defined; the light edgings to the feathers of the sides of the neck narrower and less conspicuous; the under parts less extensively washed with buff—the throat and center of the abdomen almost free of this color.

Range.—Hilly regions of Yunnan, Haut-Laos, and Tongking, so far as these lie between the Mekong River and the Black River-Red River divide.

Specimens examined.—Yunnan: Southwest: Szemao (1 male); Laos: Vientiane Province: Vientiane (1 female), Tha Ngon (3 males, 1 female); Haut-Mékong Province: Ban Houeisai (1 female, 1 unsexed), Nam Khueng (3 males, 1 female), Lo-tiao (1 male); 5e Territoire Militaire: Bountai (2 males, 4 females), Phong Saly (1 male, 1 female); Tongking: Laichau Province: Muong Mo (1 male), Muong Moun (3 males), Paham (1 male, 1 female), Laichau (1 male).

Remarks.—Since four of the five birds from Vientiane Province were shot in July and are so grayed from wear as to be subspecifically unidentifiable, the extension of *oreum's* range so far to the south is based upon a single specimen and requires confirmation.

22. PELLORNEUM RUFICEPS VIVIDUM La Touche

Pellorneum nipalense vividum La Touche, Bull. Brit. Orn. Club, vol. 42, Oct. 29, 1921, p. 17 (Hokow, southeastern Yunnan, China).

Diagnosis.—Similar to *P. r. oreum,* but separable in series by having the rufous of the forehead, crown, and nape darker (almost chestnut); the brown of the remaining upper parts deeper in tone (about like that of *P. r. mandellii*); the dark centers to the feathers of the uppermost back still more conspicuous; the under parts somewhat more boldly streaked.

Range.—The valley of the Red River from the Chinese frontier to its mouths and thence southward along the coast of the Gulf of Tongking to central Annam.

Specimens examined.—Tongking: Backan Province: Backan (1 male); Annam: Thanhhoa Province: Hoixuan (6 males, 2 females, 2 unsexed); Vinh Province: Phuqui (1 unsexed); Quangtri Province: Phuoc (1 unsexed).

23. PELLORNEUM RUFICEPS UBONENSE, new subspecies

Type.—A.N.S.P. No. 126892, adult male, collected at Ban Chanuman (lat. 16°15′ N., long. 105°00′ E.), Ubon Province, eastern Siam, on February 3, 1936, by collectors for R. Meyer de Schauensee (original number 491).

Diagnosis.—From *P. r. vividum* easily separable in series by having the rufous of the front, crown, and nape lighter and brighter; the brown of the remaining upper parts lighter and more olivaceous (less rufescent than in any one of the three precedent races); the dark centers to the feathers of the uppermost back usually absent or, if present, almost invisible; the under parts as boldly streaked, but on a ground color nearer white, less strongly washed with buff.

From *P. r. chthonium* distinguishable in series by having the brown of the upper parts slightly darker and a little more olivaceous; the central streaks of the feathers of the breast and sides of the abdomen broader and more blackish brown, on a whiter, less buffy, ground color.

Range.—Easternmost Siam (Ubon Province).

Specimens examined.—SIAM: Ubon Province: Ban Chanuman (2 males, 4 females), Ban Khemmarat (2 males, 2 females).

Remarks.—The one specimen seen from Ban Bua Yai on the plateau of eastern Siam (mentioned in Remarks under *P. r. chthonium*) does not agree well with this series and probably belongs with another race.

24. PELLORNEUM RUFICEPS subsp.

Four specimens from Pakse and Ban Kok in the Boloven region of Bas-Laos (a fifth is quite obviously mislabeled and belongs with some other population) stand very near to *P. r. ubonense,* but seem to have the brown of the upper parts a little paler. With so short a series, I am not prepared to name these birds on so slight a character, but it would be surprising if better material did not show that here also we have a distinct race.

25. PELLORNEUM RUFICEPS subsp.

A specimen taken by Boden Kloss at Daban in southern Annam is much like *P. r. acrum* above, and has the ground color of the under parts much as in *P. r. chthonium,* but differs from *all* others before me in the breadth of the dark streaks, which seem to form an almost unbroken band across the breast. Since its provenience is known to be one of the main speciation centers of southeastern Asia, this bird will probably prove to be representative of a still undescribed race.

26. PELLORNEUM RUFICEPS subsp.

Three specimens from the isolated forest at Trangbom, Bienhoa Province, Cochin-China, must for the present be left unnamed. They have the under parts somewhat as in *P. r. ubonense,* but the upper parts much more rufescent.

27. PELLORNEUM RUFICEPS EUROUM, new subspecies

Type.—U.S.N.M. No. 337119, adult male, collected at Chanthaburi (lat. 12°35′ N., long. 102°05′ E.), Chanthaburi Province, southeastern Siam, on April 19, 1937, by H. G. Deignan (original number 2527).

Diagnosis.—A very saturate race, near to *P. r. vividum,* from which it is barely distinguishable in series by having the brown of the upper parts slightly darker and even more rufescent; the dark centers to the feathers of the uppermost back less often present and then more obsolescent; the under parts washed with a very slightly warmer buff.

From *P. r. acrum* easily separable by having the rufous of the forehead, crown, and nape, and the brown of the remaining upper parts deeper in tones; the central streaks of the feathers of the breast and sides of the abdomen much broader and bolder.

Range.—Southeastern Siam (Rayong, Chanthaburi, and Trat Provinces).

Specimens examined.—Siam: Trat Province: Ban Bang Phra (1 male, 2 females); Chanthaburi Province: Chanthaburi (4 males, 2 females), Khao Sa Bap (1 male, 1 female), Khao Soi Dao (1 male, 3 females); Rayong Province: Ban Hup Bon (1 male), Ban Si R̊acha (1 female), Ban Nong Kho (1 male).

Remarks.—Under the following form I shall explain why the name *smithi* seems to me inapplicable to birds from the mainland of southeastern Siam.

28. PELLORNEUM RUFICEPS SMITHI Riley

Pellorneum smithi Riley, Proc. Biol. Soc. Washington, vol. 37, Oct. 21, 1924, p. 129 (Ko Chang, off Trat Province, southeastern Siam, at lat. 12°00′ N., long. 102°30′ E.).

Diagnosis.—The unique specimen differs from any one of 18 examples of *P. r. euroum* (including three from the nearby mainland of Trat Province) by having the rufous of the forehead, crown, and nape deeper in tone (almost chestnut); the brown of the remaining upper parts much deeper and much more rufescent; the under parts (excepting the throat and center of the abdomen) washed with dark rufescent buff.

From *P. r. insularum* of the Mergui Archipelago, the only race that approximates it in erythrism, *smithi* is easily distinguished by its generally darker and more rufescent tones and by its much broader and blacker streaks on the breast.

Range.—Ko Chang (an island off Trat Province, southeastern Siam).

Specimens examined.—SIAM: Trat Province: Ko Chang (1 female, the type).

Remarks.—The type of *P. r. smithi* has up to now been considered an "erythro" of the race inhabiting the neighboring mainland. The discoveries that the species breaks up into a bewildering number of forms in continental areas, and that subspeciation appears in the Mergui Islands and Pulau Langkawi, lend strong support to the probable validity of a race endemic to Ko Chang. Moreover, the fact that the type of *smithi* exceeds in erythrism the erythristic race *insularum,* every specimen of which in turn exceeds in erythrism the reddest examples seen of *euroum,* would seem to indicate that its characters cannot be explained as simple abnormality.

SUMMARY

1. In *Pellorneum ruficeps,* considerable variation usually treated as individual has proved to represent true subspeciation.

2. The boundaries between the ranges of subspecies are often rivers or chains of hills.

3. Examination of 339 specimens has shown that not less than 28 populations seem to deserve nomenclatorial recognition, although, whether for lack of material or other reasons, names have been used for but 23 of these; 13 names have been established for the first time.

4. The name *Pellorneum ruficeps granti* Harington, 1913, has been synonymized with *olivaceum* Jerdon, 1839, and the name *Pellorneum ruficeps jonesi* Stuart Baker, 1920, with *punctatum* Gould, 1838.

5. Type localities have been restricted whenever it has been found necessary.

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(WITH SIX PLATES)

BY
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INTRODUCTION

A study of animal life and associated ectoparasites in the Pacific war area was made by the Laboratories of Mammalogy and Acarology, United States Naval Medical Research Unit No. 2. In the course of this study at a number of island groups, land vertebrates were collected, examined for parasitic life, and made into museum skins for accurate identification. Approximately 1,300 specimens of birds were obtained in the period from June 1944 to December 1945, and now are deposited in the United States National Museum, Washington, D. C.

Field work was begun in May 1944, when an advance party headed by David H. Johnson and G. W. Wharton, Jr., was sent to the Southwest Pacific to study mite-borne scrub typhus (tsutsugamushi disease). During their period of duty in this area, they collected at Espiritu Santo (New Hebrides), Bougainville and Guadalcanal (Solomon Islands), Manus, Ponam, and Mussau (Bismarck Archipelago), and Samar (Philippine Islands). This party joined the rest of the field group in March 1945 at Guam, where laboratories were being established. Collections were then made at Guam and Rota (Mariana Islands), Ulithi and Truk (Caroline Islands), Palau Islands, Iwo Jima (Volcano Islands), and Okinawa (Riu Kiu Islands).

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The writer is indebted to Dr. Alexander Wetmore, Secretary of the Smithsonian Institution, for the opportunity to work and utilize the collections at the United States National Museum. I am very grateful to Dr. Herbert Friedmann and H. G. Deignan of the Division of Birds, U. S. National Museum, for their generous help and advice in preparing this report. I wish to thank also Dr. Ernst Mayr and Dean Amadon of the American Museum of Natural History for the opportunity of examining specimens in their charge. Lastly, I wish to acknowledge the help of Stevens Tabone in the preparation of some of the maps.

LIST OF BIRDS

Since collections were made at a number of localities, it seems advisable to have separate lists for the different areas. The map, figure 1, shows the islands visited by field parties. Where applicable, most of the nomenclature follows Mayr (Birds of the Southwest Pacific, 1945). A majority of the birds have been identified by comparing them with specimens at the United States National Museum.

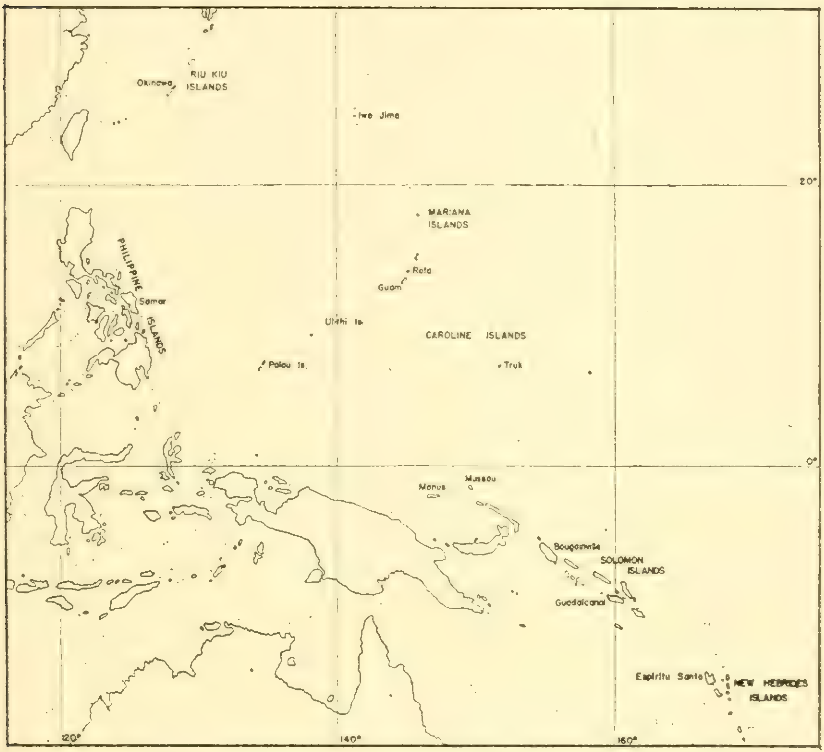


FIG. 1.—Collecting localities in the Pacific war area.

Color terms in quotation marks are those of Ridgway (Color Standards and Color Nomenclature, 1912). The specimens listed are adults unless designated as juveniles. Weights are given in grams and measurements in millimeters.

BIRDS COLLECTED AT ESPIRITU SANTO ISLAND, NEW HEBRIDES

The advance party consisting of Johnson, Wharton, Necker, Muennink, Fritts, and Carver spent the period from June 6 to June 20, 1944, at Espiritu Santo. Johnson and Necker stopped there again from January 25 to January 30, 1945. Birds were collected in the vicinity of Luganville, mostly in old plantation areas.

PTILINOPUS GREYII Bonaparte

Ptilinopus greyii BONAPARTE, Iconogr. Pigeons, 1857, pl. 20. (Isle of Pines and Loyalty Islands.)

Luganville: 13 km. W. by N. of—1 male, June 20.

COLUMBA VITIENSIS LEOPOLDI (Tristram)

Ianthaenas leopoldi TRISTRAM, Ibis, 1879, p. 193. (Island of Vaté, New Hebrides.)

Luganville: 13 km. W. by N. of—1 female, June 20.

This pigeon was found in heavy jungle near a stream.

CACOMANTIS PYRROPHANUS SCHISTACEIGULARIS Sharpe

Cacomantis schistaceigularis SHARPE, Ibis, 1900, p. 338. (Espiritu Santo, New Hebrides.)

Luganville: 4 km. NE. by N. of—1 unsexed (alcoholic), January 26.

Birds were observed in old plantation areas. The specimen obtained was in molt.

CHALCITES LUCIDUS LAYARDI (Mathews)

Chrysococcyx layardi MATHEWS, Austr. Av. Rec., vol. 1, 1912, p. 16. (New Caledonia.)

Luganville: 4 km. NE. by N. of—1 unsexed (alcoholic), January 26.

This molting bird was shot in an old native garden.

RHIPIDURA FULIGINOSA BRENCHLEYI Sharpe

Rhipidura brenchleyi SHARPE, Cat. Birds Brit. Mus., vol. 4, 1879, p. 311. (Aneiteum, New Hebrides.)

Luganville: 4 km. NE. by N. of—1 unsexed (alcoholic), January 26.

ARTAMUS LEUCORHYNCHUS TENUIS Mayr

Artamus leucorhynchus tenuis MAYR, Auk, vol. 60, 1943, p. 268. (Gaua, Banks Island.)

Luganville: 4 km. NE. by E. of—1 unsexed, June 19.

APLONIS ZELANDICUS RUFIPENNIS Layard

Aplonis rufipennis LAYARD, Ibis, 1881, p. 542. (Vaté, New Hebrides.)

Luganville: 4 km. NE. by N. of—1 unsexed (alcoholic), January 26.

ZOSTEROPS FLAVIFRONS BREVICAUDA Murphy and Mathews

Zosterops flavifrons brevicauda MURPHY AND MATHEWS, Amer. Mus. Novit., No. 356, 1929, p. 3. (Malo Island, New Hebrides.)

Luganville: 4 km. NE. by N. of—1 unsexed (alcoholic), January 26.

BIRDS COLLECTED AT BOUGAINVILLE AND GUADALCANAL, SOLOMON ISLANDS

The field group consisting of Johnson, Wharton, Muennink, Necker, Fritts, and Carver arrived at Bougainville on June 27, 1944, and remained there, except for short trips, until about January 25, 1945. During this time, Japanese forces were in control of most of the island and the party was able to collect only in the vicinity of Cape Torokina on Empress Augusta Bay (see fig. 2). Specimens were taken in lowland jungles, swamps, and on beaches at Cape Torokina and as far south as the Jaba River.

Muennink collected at Guadalcanal during the period from November 11, 1944, to January 6, 1945. Johnson was at the island from November 11 to 16. Collections were made at Lunga Point and at Doma Cove as shown in figure 3.

PODICEPS RUFICOLLIS COLLARIS Mayr

Podiceps ruficollis collaris MAYR, Amer. Mus. Novit., No. 1294, 1945, p. 1. (Bougainville.)

Bougainville Island: Cape Torokina—1 male, September 15.

Several dabchicks were seen in a swampy area. The specimen obtained has been compared with the type at the American Museum of Natural History.

Measurements of this specimen are: wing 106, exposed culmen 26, and tarsus 36. One set of four eggs was collected from a nest at the fresh-water swamp. The eggs are white with a greenish cast, ovate, and measure 24.6-26.4 (25.5) x 32.9-34.9 (33.8).

NYCTICORAX CALEDONICUS MANDIBULARIS Ogilvie-Grant

Nycticorax mandibularis OGILVIE-GRANT, Proc. Zool. Soc. London, 1888, p. 203. (Aola, Guadalcanar, Solomon Group.)

Bougainville Island: Cape Torokina—1 male, 1 female, October 6, January 10. Gaudalcanal Island: Doma Cove—1 juvenile male, January 2.

Measurements of Bougainville specimens: adult male, wing 263, exposed culmen 72, tarsus 83; adult female, wing 267, exposed culmen 70, tarsus 82.

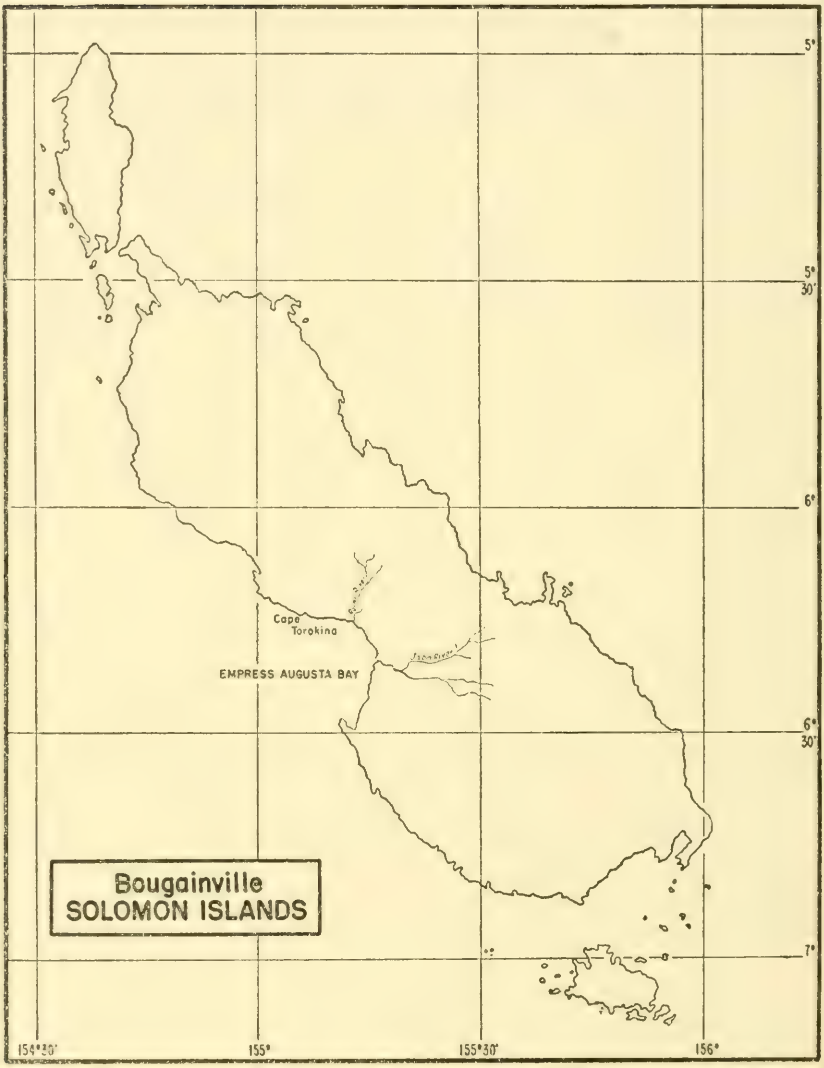


Fig. 2.—Collecting localities on Bougainville Island.

ANAS SUPERCILIOSA PELEWENSIS Hartlaub and Finsch

Anas superciliosa var. *pelewensis* HARTLAUB AND FINSCH, Proc. Zool. Soc. London, 1872, p. 108. (Pelew Islands.)

Bougainville Island: Cape Torokina—1 male, 2 females, January 26.

Two specimens were in molt when collected.

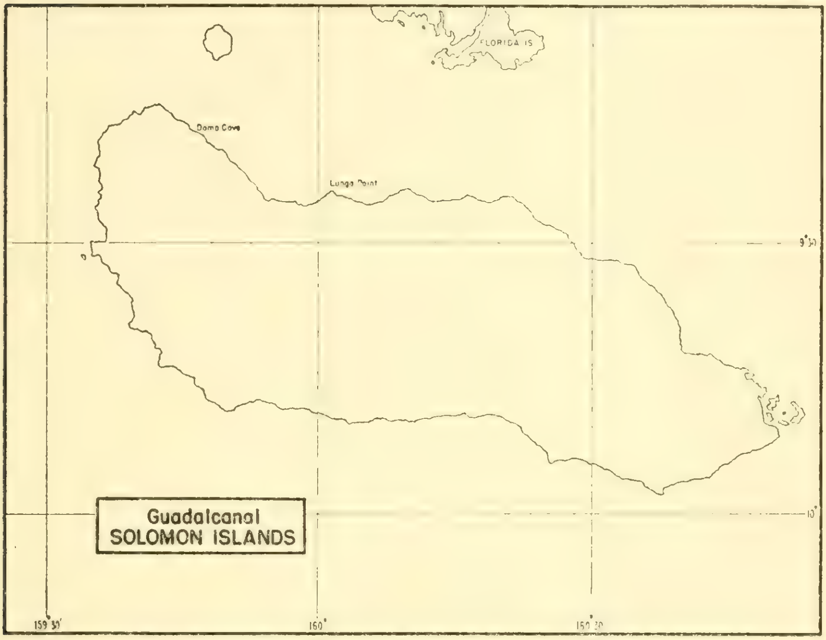


FIG. 3.—Collecting localities on Guadalcanal Island.

AVICEDA SUBCRISTATA PROXIMA Mayr

Aviceda subcristata proxima MAYR, Amer. Mus. Novit., No. 1294, 1945, p. 10. (Kieta District, Bougainville Island.)

Bougainville Island: Cape Torokina—1 female, October 17.

This specimen has been compared with the type at the American Museum of Natural History. Muennink shot this hawk in thick underbrush.

HALIASTUR INDUS GIRRENERA (Vieillot)

Haliaetus girrenera VIEILLOT, Gal. Ois., vol. 1, 1822, p. 31, pl. 10. (India, Bengal, Pondichery, Coromandel, and Malabar, also New Holland according to Latham. Restricted type locality, New South Wales [the plate represents the Australian form].)

Guadalcanal Island: Doma Cove—1 female, December 14.

ACCIPITER NOVAEHOLLANDIAE BOUGAINVILLEI (Rothschild and Hartert)

Astur etorques bougainvillei ROTHSCHILD AND HARTERT, Nov. Zool., vol. 12, 1905, p. 250. (Bougainville Island.)

Bougainville Island: Cape Torokina—2 juvenile males, August 10, 14.

One bird was in postjuvenal molt when taken.

ACCIPITER NOVAEHOLLANDIAE PULCHELLUS (Ramsay)

Astur pulchellus RAMSAY, Journ. Linn. Soc. London, vol. 16, 1881, p. 131. (Cape Pitt, Solomon Islands, *ex* Proc. Linn. Soc. New South Wales, vol. 4, pt. 1, 1879, p. 66.)

Guadalcanal Island: Doma Cove—1 juvenile male, 1 juvenile unsexed, December 20, January 1.

ACCIPITER ALBOGULARIS G. R. Gray

Accipiter albogularis G. R. GRAY, Ann. and Mag. Nat. Hist. ser. 4, vol. 5, 1870, p. 327. ("Hada or Recherche Bay," San Cristoval.)

Guadalcanal Island: Doma Cove—1 female, 2 juvenile males, December 20, 27, January 1.

The female is in dark phase, with light coloring present only on the inner webs of wing feathers. This bird was molting body feathers.

MEGAPODIUS FREYCINET EREMITA Hartlaub

Megapodius eremita HARTLAUB, Proc. Zool. Soc. London, 1867 (1868), p. 830. (Echiquier Island = Ninigo Islands.)

Bougainville Island: Cape Torokina—2 females, July 30, October 16. Guadalcanal Island: Doma Cove—1 male, November 17; Lunga Point—1 unsexed, December 26.

TURNIX MACULOSA SALOMONIS Mayr

Turnix maculosa salomonis MAYR, Amer. Mus. Novit., No. 1007, 1938, p. 3. (Guadalcanal, Solomon Islands.)

Guadalcanal Island: Lunga Point—1 juvenile female, November 30.

This specimen has been noted by Beecher (Fieldiana, Zoology, vol. 31, 1945, p. 35). It was taken by Muennink in a grassy opening used as a recreation area by service personnel.

POLIOLIMNAS CINEREUS LEUCOPHRYS (Gould)

Porzana leucophrys Gould, Proc. Zool. Soc. London, 1847, p. 33. (Port Essington and northern Australia.)

Bougainville Island: Cape Torokina—1 male, September 15.

This single specimen has been compared with the large series of rails in the collection of the American Museum of Natural History and appears to belong to the race *P. c. leucophrys*. It is similar to birds of this race from New Guinea and New Britain in coloring of the upper parts and in ventral coloration except that the under tail-coverts and sides are darker brown than in most of these individuals, and the occiput has a more brownish-olive tinge. The measurements of the bird are: wing 95, tail 52, exposed culmen 23.5, tarsus 36.

This bird differs from examples of the race *P. c. meeki* (Hartert), from St. Matthias Island, in being much paler below and having a longer bill. It is darker and larger than a male from Samoa of the race *P. c. tannensis* (Forster).

To my knowledge this is the first record from the Solomon Islands of this widely distributed species. It was taken by Necker at a fresh-water swamp, where rails and dabchicks also were observed.

PLUVIALIS DOMINICA FULVA (Gmelin)

Charadrius fulvus Gmelin, Syst. Nat., vol. 1, pt. 2, 1789, p. 687. (Tahiti.)

Bougainville Island: Cape Torokina—1 male, 1 female, January 10; Jaba River—1 male, 2 females, September 26, 27.

Birds taken in September were in breeding plumage. Beginning in September shore birds were seen in large numbers; they were on beaches and air strips.

CHARADRIUS LESCHENAULTII Lesson

Charadrius Leschenaultii Lesson, Dict. Sci. Nat., éd. Levrault, vol. 42, 1826, p. 36. (Pondichery, India.)

Bougainville Island: Jaba River—1 female, September 26.

The specimen is in winter plumage.

ACTITIS HYPOLEUCOS (Linnaeus)

Tringa Hypoleucos Linnaeus, Syst. Nat., ed. 10, 1758, p. 149. (Europe, restricted type locality, Sweden.)

Bougainville Island: Cape Torokina—1 female, 1 unsexed, January 10; Jaba River—1 female, September 26. Guadalcanal Island: Doma Cove—1 female, December 10.

HETEROSCELUS INCANUS BREVIPES (Vieillot)

Totanus brevipes Vieillot, Nouv. Dict. Hist. Nat., vol. 6, 1816, p. 410. (No locality given; the type is from Timor.)

Bougainville Island: Jaba River—1 juvenile male, September 26.

CALIDRIS ACUMINATA (Horsfield)

Totanus acuminatus Horsfield, Trans. Linn. Soc. London, vol. 13, pt. 1, 1821, p. 192. (Java.)

Bougainville Island: Cape Torokina—1 juvenile male, November 1; Reini River—1 female (skeleton), October 23.

STERNA HIRUNDO LONGIPENNIS Nordmann

Sterna longipennis Nordmann, *in* Erman's Verz. Thier. Pflanz., 1835, p. 17. (Mouth of the Kutchui River, Sea of Okhotsk.)

Bougainville Island: Cape Torokina—1 male, January 10.

ANOÜS TENUIROSTRIS MINUTUS Boie

Anous minutus Boie, Isis, 1844, col. 188. (New Holland = Raine Island, Australia, *apud* Mathews.)

Bougainville Island: Cape Torokina—1 female, January 10.
The bird was in postjuvenal molt when taken.

PTILINOPUS SUPERBUS SUPERBUS (Temminck)

Columba Superba Temminck, *in* Knip, Les Pigeons, 1810, les colombes, p. 75, pl. 33. ("O-Taiti," error = Halmahera.)

Guadalcanal Island: Lunga Point—1 male, 3 juvenile females, November 16, 22, 24.

PTILINOPUS VIRIDIS LEWISII (Ramsay)

Ptilopus Lewisii Ramsay, Nature, vol. 25, January 19, 1882, p. 282. (Solomon Islands = Lango, Guadalcanar *ex* Proc. Linn. Soc. New South Wales, vol. 6, March 1882, p. 724.)

Bougainville Island: Cape Torokina—2 males, October 20, 26; Jaba River—1 male, September 26. Guadalcanal Island: Lunga Point—2 males, 1 female, 1 juvenile male, November 21, 22, December 17.

DUCULA RUBRICERA RUFIGULA (Salvadori)

Carpophaga rufigula SALVADORI, Atti R. Acad. Sci. Torino, vol. 13, 1878, p. 536. (Wanga, San Cristobal Island, Solomon Islands.)

Bougainville Island: Cape Torokina—2 males, 1 female, August 28, October 18, 27. Guadalcanal Island: Lunga Point—3 males, 1 female, November 14, 21, 22; Doma Cove—2 females, January 6.

Specimens collected in October, November, and January were molting body and wing feathers.

DUCULA PISTRINARIA PISTRINARIA Bonaparte

Ducula pistrinaria BONAPARTE, Consp. Av., vol. 2, 1855, p. 36. (St. George, Solomon Islands.)

Bougainville Island: Cape Torokina—2 males, August 23, October 27.

The birds were molting body feathers when collected.

MACROPYGIA MACKINLAYI AROSSI Tristram

Macropygia arossi TRISTRAM, Ibis, October 1879, p. 443. (Makira Harbor, San Cristobal Island.)

Bougainville Island: Jaba River—1 female, August 30. Guadalcanal Island: Doma Cove—1 female, December 14.

CHALCOPHAPS STEPHANI MORTONI Ramsay

Chalcophaps mortoni RAMSAY, Nature, vol. 25, Jan. 19, 1882, p. 282. (Solomon Islands.) Proc. Linn. Soc. New South Wales, vol. 6, March 1882, p. 725. (Ugi, Solomon Islands.)

Guadalcanal Island: Doma Cove—1 female, December 6.

CALOENAS NICOBARICA NICOBARICA (Linnaeus)

Columba nicobarica LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 164. ("*insula* Nicombar *prope* Pegu *indicum*" = Nicobar Islands.)

Guadalcanal Island: Doma Cove—1 male, 1 female, December 10.

The two birds were shot by Muennink in a grove of large trees.

EOS CARDINALIS (G. R. Gray)

Lorius cardinalis G. R. GRAY, Gen. Birds, vol. 3, 1849, app., p. 20. (Solomon Islands, based on Voy. Pôle Sud, Atlas, Ois., pl. 24 bis, fig. 2.)

Bougainville Island: Cape Torokina—4 males, 6 females, August 28, September 11, 21, 22, October 1, 12, 18, 20, 25. Guadalcanal Island: Lunga Point—1 male, November 14.

Birds collected in September, October, and November were in molt. Wing length of males 171-176 (173), females 171-183 (176).

TRICHOGLOSSUS HAEMATOD MASSENA Bonaparte

Trichoglossus massena BONAPARTE, Rev. et Mag. Zool., ser. 2, vol. 6, 1854, p. 157. ("Ins. Polynesiae," the type agrees with specimens from New Hebrides, *fide* Hartert, Nov. Zool., vol. 32, 1925, p. 123.)

Bougainville Island: Cape Torokina—1 male, October 19. Guadalcanal Island: Lunga Point—3 males, 2 females, November 14, 15, 22, 27; Doma Cove—1 female, January 2.

These specimens appear to be *T. h. massena,* as suggested by Mayr (Birds of the Southwest Pacific, 1945, p. 230). They compare favorably with a bird of this race from the New Hebrides. Birds from the Admiralty Islands, *T. h. flavicans* Cabanis and Reichenow, have lighter upperparts than the birds from the Solomon Islands.

Wing lengths of three adult males (Guadalcanal) 126-131 (129), one male (Bougainville) 135, three adult females (Guadalcanal) 121-125 (123). Length of exposed culmen without cere of five adults 18.1-20.1 (18.9). Birds taken in November and January were in molt.

LORIUS CHLOROCERCUS Gould

Lorius chlorocercus GOULD, Proc. Zool. Soc. London, 1856, p. 137. (San Cristóbal, Solomon Islands.)

Guadalcanal Island: Doma Cove—2 males, 2 females, December 16, 17, 27.

Two of the birds were in molt when collected.

VINI MARGARETHAE (Tristram)

Charmosyna margarethae TRISTRAM, Ibis, 1879, p. 442, pl. 12. (Makira Harbor, San Cristóbal, Solomon Islands.)

Bougainville Island: Cape Torokina—1 female, October 19. Guadalcanal Island: Lunga Point—3 males, 1 female, November 15, 16, 27.

MICROPSITTA FINSCHII NANINA (Tristram)

Nasiterna nanina TRISTRAM, Ibis, 1891, p. 608. (Bugotu, Solomon Islands.)

Bougainville Island: Cape Torokina—1 male, October 8.

CACATUA DUCROPS (Bonaparte)

Plyctolophus DuCrops "Hombron et Jacquinot" BONAPARTE, Compt. Rend. Acad. Sci. Paris, vol. 30, 1850, p. 138, *ex* Voy. Pôle Sud, Atlas, Ois., pl. 26, fig. 1. (Solomon Islands.)

Bougainville Island: Cape Torokina—4 males, 1 female, August 15, September 7, 18, 20. Guadalcanal Island: Doma Cove—1 unsexed, January 4.

LARIUS RORATUS SOLOMONENSIS (Rothschild and Hartert)

Eclectus pectoralis solomonensis ROTHSCHILD AND HARTERT, Nov. Zool., vol. 8, 1901, p. 81. (Fauro, Shortland Group.)

Bougainville Island: Cape Torokina—4 males, 2 females, August 31, October 13, 14, 20, 26. Guadalcanal Island: Doma Cove—2 males, December 12, 26; Lunga Point—1 male, 1 female, November 24.

	Wing	Tail	Exposed culmen
3 males (Guadalcanal)...	232-237 (235)	110-115 (113)	36.9-38.1 (37.2)
4 males (Bougainville)..	236-242 (239)	112-119 (116)	41.0-41.8 (41.2)

Birds from Bougainville appear larger than those from Guadalcanal, especially in length of exposed culmen. This seems to be a slight tendency toward *Larius roratus goodsoni* Hartert of the Admiralty Islands, which has a larger bill.

Seven of the birds taken in October, November, and December were molting body feathers and wing feathers.

CACOMANTIS VARIOLOSUS ADDENDUS Rothschild and Hartert

Cacomantis addendus ROTHSCHILD AND HARTERT, Nov. Zool., vol. 8, 1901, p. 185. Kulambangra, Solomon Islands.)

Guadalcanal Island: Doma Cove—1 juvenile unsexed, January 4.

CHALCITES LUCIDUS LUCIDUS (Gmelin)

Cuculus lucidus GMELIN, Syst. Nat., vol. 1, pt. 1, 1788, p. 421. ("*in* nova Seelandia" = New Zealand.)

Bougainville Island: Cape Torokina—1 male, September 5.

EUDYNAMIS SCOLOPACEA ALBERTI Rothschild and Hartert

Eudynamis orientalis alberti ROTHSCHILD AND HARTERT, Nov. Zool., vol. 14, 1907, p. 440. (Gizo, Solomon Islands.)

Guadalcanal Island: Doma Cove—1 juvenile male, December 26. The specimen was in postjuvenal molt.

CENTROPUS MILO MILO Gould

Centropus milo Gould, Proc. Zool. Soc. London, 1856, p. 136. (Guadalcanar, Solomon Islands.)

Guadalcanal Island: Lunga Point—1 male, 1 juvenile male, November 20; Doma Cove—1 female, December 13.

Adult birds were molting wing and body feathers.

NINOX JACQUINOTI EICHHORNI (Hartert)

Spiloglaux jacquinoti eichhorni Hartert, Amer. Mus. Novit., No. 364, 1929, p. 7. (Choiseul, Solomon Islands.)

Bougainville Island: Cape Torokina—1 female, October 26.

COLLOCALIA VANIKORENSIS VANIKORENSIS (Quoy and Gaimard)

Hirundo vanikorensis Quoy and Gaimard, Voy. *Astrolabe*, Zool., vol. 1, 1830, p. 206, Atlas, Ois., pl. 12, fig. 3. (île vanikoro.)

Guadalcanal Island: Doma Cove—1 female, January 1.

HEMIPROCNE MYSTACEA WOODFORDIANA (Hartert)

Macropteryx mystacea woodfordiana Hartert, Nov. Zool., vol. 3, 1896, p. 19. (Guadalcanar.)

Bougainville Island: Cape Torokina—1 nestling (alcoholic), November 3.

CEYX LEPIDUS PALLIDUS Mayr

Ceyx lepidus pallidus Mayr, Amer. Mus. Novit., No. 820, 1935, p. 2. (Bougainville, Solomon Islands.)

Bougainville Island: Cape Torokina—1 male, August 30.

HALCYON CHLORIS ALBERTI Rothschild and Hartert

Halcyon tristrami alberti Rothschild and Hartert, Nov. Zool., vol. 12, 1905, p. 256. (Kulambangra, Solomon Islands.)

Bougainville Island: Cape Torokina—1 male, 2 females, 1 juvenile female, July 28, 30, October 26, 27. Guadalcanal Island: Doma Cove—1 female, December 30.

The female from Guadalcanal has a deeper ochraceous coloring on the collar, malar stripe, and in the supra-loral region, and has more blue and less green on the upperparts than the females from Bougainville.

HALCYON SANCTA subsp. (Probably SANCTA Vigors and Horsfield.)

Bougainville Island: Cape Torokina—1 juvenile male, September 26; Jaba River—1 male, 1 juvenile female, September 17, 26.

These specimens apparently belong to the race *Halcyon s. sancta*, which Mathews (Systema Avium Australasianarum, pt. 1, 1927, p. 379) lists as wintering in the Solomons.

HALCYON LEUCOPYGIA (Verreaux)

Cyanalcyon leucopygius Verreaux, Rev. et Mag. Zool., ser. 2, vol. 10, 1858, p. 305. (Solomon Islands.)

Bougainville Island: Cape Torokina—2 males, 3 females, 1 juvenile female, July 28, September 11, October 12, 17, 20, 25. Guadalcanal Island: Doma Cove—2 females, 1 juvenile male, December 12, 26, 30.

Measurements of adult females from the two islands are similar: wing 87-89, tail 61-64, bill from nostril 34-35. An egg found in the oviduct of a female taken on October 17 is white, oval, and measures 28.5 x 25.1. Birds taken in July and September were molting body feathers.

EURYSTOMUS ORIENTALIS SOLOMONENSIS Sharpe

Eurystomus solomonensis Sharpe, Proc. Zool. Soc. London, 1890, p. 552. (Solomon Islands.)

Bougainville Island: Cape Torokina—3 males, 2 females, 1 juvenile female, 1 nestling (alcoholic), July 27, August 22, 28, September 5, October 8, November 1. Guadalcanal Island: Lunga Point—1 male, 1 female, November 17; Doma Cove—1 female, 1 juvenile female, December 30, January 5.

Measurements of these specimens are within the range of those listed by Ripley (Proc. Biol. Soc. Washington, vol. 55, 1942, p. 174). The wing lengths of birds from Bougainville is slightly greater than those of birds from Guadalcanal. The nestling was taken on August 31. A female collected July 27 contained 4 large eggs. Molting birds were collected in July, August, and December.

RHYTICEROS PLICATUS MENDANAE Hartert

Rhyticeros plicatus merdanae Hartert, Bull. Brit. Orn. Club, vol. 45, 1924, p. 46. (Guadalcanar, Solomon Islands.)

Guadalcanal Island: Lunga Point—1 male, 2 females, November 23; Doma Cove—1 female, December 10.

Hornbills appeared to be less common at Bougainville than at Guadalcanal. The specimens were in molt when collected.

EDOLISOMA HOLOPOLIUM HOLOPOLIUM (Sharpe)

Graucalus holopolius SHARPE, Proc. Zool. Soc. London, 1888, p. 184. (Aola, Guadalcanar, Solomon Islands.)

Bougainville Island: Cape Torokina—2 males, October 12, 27. Guadalcanal Island: Doma Cove—1 female, December 13.

The measurements of the wings of the two males (115, 118) are within the limits of the series studied by Mayr (Amer. Mus. Novit., No. 504, 1931, p. 17). All the specimens were in molt when collected.

EDOLISOMA TENUIROSTRE SATURATIUS Rothschild and Hartert

Edolisoma erythropygium saturatius ROTHSCHILD AND HARTERT, Nov. Zool., vol. 9, 1902, p. 582. (Ysabel Island, Solomon Islands.)

Bougainville Island: Cape Torokina—1 juvenile male, October 28. One specimen in postjuvenal molt was taken.

EDOLISOMA TENUIROSTRE ERYTHROPYGIUM Sharpe

Edolisoma erythropygium SHARPE, Proc. Zool. Soc. London, 1888, p. 184. (Guadalcanar, Solomon Group.)

Guadalcanal Island: Lunga Point—2 females, November 16, 20; Doma Cove—2 unsexed juveniles, January 2.

CORACINA LINEATA NIGRIFRONS (Tristram)

Graucalus nigrifrons TRISTRAM, Ibis, 1892, p. 294. (Bugotu, Ysabel Island.)

Bougainville Island: Cape Torokina—1 female, October 12.

CORACINA LINEATA SOLOMONENSIS (Ramsay)

Graucalus solomonensis RAMSAY, Proc. Linn. Soc. New South Wales, vol. 4, 1879, p. 314. (Guadalcanar, Solomon Group.)

Guadalcanal Island: Lunga Point—1 male, November 14; Doma Cove—1 juvenile male, December 12.

The birds were in molt when collected.

CORACINA PAPUENSIS PERPALLIDA Rothschild and Hartert

Coracina papuensis perpallida ROTHSCHILD AND HARTERT, Nov. Zool., vol. 23, 1916, p. 290. (Bougainville Island.)

Bougainville Island: Cape Torokina—3 males, August 31, October 26, 27; Jaba River—1 male, September 26.

The birds were in molt when collected.

CORACINA PAPUENSIS ELEGANS (Ramsay)

Graucalus elegans Ramsay, Proc. Linn. Soc. New South Wales, vol. 6, 1881, p. 176. (Guadalcanar Island.)

Guadalcanal Island: Lunga Point—1 male, 1 unsexed juvenile, November 20, 27; Doma Cove—1 male, December 12.

All specimens were in molt when collected.

CORACINA NOVAEHOLLANDIAE MELANOPS (Latham)

Corvus melanops Latham, Index Ornith., Suppl., 1801, p. XXIV. (New Holland = Sidney, New South Wales.)

Bougainville Island: Jaba River—1 juvenile male, August 31.

GYMNORHINA TIBICEN subsp.

Guadalcanal Island: Lunga Point—1 juvenile female, November 30.

This juvenile specimen has been recorded by Beecher (Fieldiana. Zoology, vol. 3, 1945, p. 36). He considers an adult, which was collected from the same locality, to be near *Gymnorhina tibicen tibicen* (Latham). This immature may have been an imported captive bird since it has a growth on its right foot which resembles bumblefoot, a disease often found in caged birds.

CORVUS MEEKI Rothschild

Corvus meeki Rothschild, Bull. Brit. Orn. Club, vol. 15, 1904, p. 21. (Bougainville Island.)

Bougainville Island: Cape Torokina—1 female, October 16.

RHIPIDURA COCKERELLI SEPTENTRIONALIS Rothschild and Hartert

Rhipidura cockerelli septentrionalis Rothschild and Hartert, Bull. Brit. Orn. Club, vol. 36, 1916, p. 73. (Bougainville.)

Bougainville Island: Cape Torokina—1 male, August 31.

RHIPIDURA COCKERELLI COCKERELLI (Ramsay)

Sauloprocta cockerelli Ramsay, Nature, vol. 20, June 5, 1879, p. 125; Proc. Linn. Soc. New South Wales, vol. 4, pt. 1, 1879, p. 81. (Lango, Guadalcanar, Solomon Group.)

Guadalcanal Island: Doma Cove—2 males, 1 female, 1 unsexed, December 17, 20, 22.

RHIPIDURA LEUCOPHRYS MELALEUCA (Quoy and Gaimard)

Muscipeta melaleuca Quoy and Gaimard, Voy. *Astrolabe,* Zool., vol. 1, 1830, p. 180; Atlas, Ois., pl. 4, fig. 3. ("hâvre carteret," New Ireland.)

Bougainville Island: Cape Torokina—2 males, September 17; Jaba River—1 unsexed, September 26.

A nest containing one egg was found on September 11.

MONARCHA CASTANEIVENTRIS ERYTHROSTICTA (Sharpe)

Pomarea erythrosticta Sharpe, Proc. Zool. Soc. London, 1888, p. 185. (Fauro, Solomon Group.)

Bougainville Island: Cape Torokina—1 male, October 19.

MONARCHA CASTANEIVENTRIS CASTANEIVENTRIS Verreaux

Monarcha castaneiventris Verreaux, Rev. et Mag. Zool., 1858, p. 304. (I'ile Samoa = Solomon Islands, *ex* Rothschild and Hartert, Nov. Zool., vol. 9, 1902, p. 583.)

Guadalcanal Island: Lunga Point—3 males, 1 female, November 21, 24, 27; Doma Cove—1 male, December 22.

One specimen taken in December was molting wing feathers.

MONARCHA BARBATA BARBATA Ramsay

Monarcha barbata Ramsay, Nature, vol. 20, 1879, p. 125. ("Guadalcana" = Guadalcanal.)

Bougainville Island: Cape Torokina—1 male, October 5. Guadalcanal Island: Doma Cove—1 male, December 27.

MYIAGRA FERROCYANEA CINEREA (Mathews)

Submyiagra ferrocyanea cinerea Mathews, Nov. Zool., vol. 34, 1928, p. 373. (Bougainville Island.)

Bougainville Island: Cape Torokina—1 male, 1 female, September 17, October 31; Jaba River—1 female, August 31.

MYIAGRA FERROCYANEA FERROCYANEA Ramsay

Myiagra ferrocyanea Ramsay, Nature, vol. 20, 1879, p. 125; Proc. Linn. Soc. New South Wales, vol. 4, pt. 1, 1879, p. 78. (Guadalcanar, Solomon Islands.)

Guadalcanal Island: Lunga Point—1 male, November 16; Doma Cove—2 males, December 13.

The wing length of these three males from Guadalcanal is 65-66; that of one male of *M. f. cinerea* from Bougainville is 70.

The bird taken in November was molting tail feathers.

PACHYCEPHALA PECTORALIS BOUGAINVILLEI Mayr

Pachycephala pectoralis bougainvillei MAYR, Amer. Mus. Novit., No. 522, 1932, p. 10. (Bougainville Island, Solomon Islands.)

Bougainville Island: Cape Torokina—1 male, October 29.

PACHYCEPHALA PECTORALIS CINNAMOMEA (Ramsay)

Pseudorectes cinnamomeum RAMSAY, Nature, vol. 20, 1879, p. 125. ("Guadalcana" = Guadalcanar.)

Guadalcanal Island: Doma Cove—5 males, 1 female, 1 unsexed (male?), December 6, 12, 13, 15, 17, 20, 27.

APLONIS CANTOROIDES (G. R. Gray)

Calornis cantoroides G. R. GRAY, Proc. Zool. Soc. London, 1861 (1862), p. 431. (Mysol Island.)

Bougainville Island: Cape Torokina—2 females, 1 juvenile female, July 30, September 6, 14; Jaba River—1 male, September 26. Guadalcanal Island: Lunga Point—1 female, November 22; Doma Cove—1 juvenile male, December 10.

APLONIS GRANDIS GRANDIS (Salvadori)

Lamprocorax grandis SALVADORI, Ornith. Pap. e. Mol., vol. 2, 1881, p. 460, new name for *Lamprotornis fulvipennis* Pucheran, Voy. Pôle Sud, Zool., vol. 3, 1853, p. 81, Ysabel Island, Solomon Islands. (*nec* Swainson, Anim. Menag. 1837, p. 298.)

Bougainville Island: Cape Torokina—5 males, 4 females, September 5, 14, 16, October 21, 25, 26, November 1.

Many of the specimens collected were in molt.

APLONIS GRANDIS MACRURUS Mayr

Aplonis grandis macrura MAYR, Amer. Mus. Novit., No. 504, 1931, p. 21. (Guadalcanar Island, British Solomon Islands.)

Guadalcanal Island: Lunga Point—2 males, 2 females, November 16.

	Wing	Tail
Aplonis grandis grandis:		
5 males	139-147 (143)	101-109 (105)
4 females	132-135 (134)	93- 99 (97)
Aplonis grandis macrurus:		
2 males	141-144 (142)	106-112 (109)
2 females	127-133 (130)	102-103 (102.5)

The measurements of these specimens bear out the findings of Mayr (Amer. Mus. Novit., No. 504, 1931, p. 21). The character, used by Mayr, of the feathers of the throat being broader and shorter in *A. g. macrurus* as compared with *A. g. grandis* is discernible but not conspicuous. Specimens were in molt when collected.

APLONIS METALLICUS NITIDUS (G. R. Gray)

Calornis nitida G. R. Gray, Proc. Zool. Soc. London, 1858, p. 181. (New Ireland.)

Bougainville Island: Jaba River—1 male, 1 juvenile female, August 31. Guadalcanal Island: Lunga Point—2 males, 3 juvenile males, November 14, 16, 20, 22; Doma Cove—1 juvenile female, 1 unsexed, January 5.

The adult male from Bougainville has a deep coppery sheen on the head, mantle, throat, and upper breast. Short, fine feathers cover the nostril. The juvenile from this same island had a copper sheen on the head and, to a slight extent, on the mantle. Below, the throat is finely streaked and the breast, belly, and sides more heavily streaked. The midportion of the belly is yellowish white. These two birds have a gloss different from that on birds taken at Guadalcanal, but in comparison with a large series at the American Museum of Natural History, it is evident that there is considerable variation in the coloration of these birds.

Two birds taken in January were in molt.

MINO DUMONTII KREFFTI (Sclater)

Gracula kreffti Sclater, Proc. Zool. Soc. London, 1869, p. 120, pl. 9. (Solomon Islands.)

Bougainville Island: Cape Torokina—3 males, 3 females, July 29, August 8, September 8, October 25, 26.

Specimens collected in July, August, and September were in molt.

MINO DUMONTII SANFORDI Hartert

Mino dumontii sanfordii Hartert, Amer. Mus. Novit., No. 364, 1929, p. 18. (Guadalcanar Island.)

Guadalcanal Island: Lunga Point—1 male, 1 female, November 17; Doma Cove—1 juvenile unsexed, December 17.

Birds taken in November were molting wing and body feathers.

MYZOMELA LAFARGEI LAFARGEI Pucheran

Myzomela lafargei PUCHERAN, Voy. Pôle Sud, Zool., vol. 3, 1853, p. 98. (Ysabel Island.)

Bougainville Island: Cape Torokina—1 male, 1 juvenile male, October 14, 26.

MYZOMELA MELANOCEPHALA (Ramsay)

Cinnyris melanocephalus RAMSAY, Nature, vol. 20, June 5, 1879, p. 125 ("Guadalcana" = Guadalcanal.)

Guadalcanal Island: Lunga Point—2 males, November 14, 15; Doma Cove—1 male, December 15.

All specimens were in molt when collected.

NECTARINIA JUGULARIS FLAVIGASTER Gould

Nectarinia flavigastra GOULD, Proc. Zool. Soc. London, 1843, p. 104. (New Ireland.)

Guadalcanal Island: Lunga Point—1 male, 2 unsexed (female plumage), November 15, 16, 20.

DICAEUM AENEUM BECKI Hartert

Dicaeum aeneum becki HARTERT, Amer. Mus. Novit., No. 364, 1929, p. 9. (Guadalcanar.)

Guadalcanal Island: Lunga Point—1 unsexed (alcoholic), November 17; Doma Cove—1 unsexed, December 24.

DICAEUM AENEUM AENEUM Pucheran

Dicaeum aeneum PUCHERAN, Voy. Pôle Sud, Zool., vol. 3, 1853, p. 97. ("San Jorge" = St. George Island, Solomon Islands.)

Bougainville Island: Cape Torokina—4 males, 1 female, 1 juvenile male, September 11, 19, October 20, 21, 31, November 1.

ZOSTEROPS METCALFEI EXIGUA Murphy

Zosterops metcalfei exigua MURPHY, Amer. Mus. Novit., No. 365, 1929, p. 5. (Shortland Island, Solomon Group.)

Bougainville Island: Cape Torokina—3 males, 3 females, September 14, October 25, 26, 31.

One bird taken in October was in molt.

BIRDS COLLECTED IN THE BISMARCK ARCHIPELAGO

Manus and Ponam in the Admiralty Islands were visited by Johnson from August 13 to August 24, 1944. He also collected in the St. Matthias Islands, visiting Mussau Island on August 25.

PTILINOPUS SOLOMONENSIS JOHANNIS (Sclater)

Ptilopus johannis SCLATER, Proc. Zool. Soc. London, 1877, p. 556. (Wild and D'Entrecasteaux Islands, Admiralty Islands.)

Admiralty Islands: Ponam Islet (north of Manus Island)—1 female, August 13.

This bird has been compared with specimens in the collection at the American Museum of Natural History.

TRICHOGLOSSUS HAEMATOD FLAVICANS Cabanis and Reichenow

Trichoglossus flavicans CABANIS AND REICHENOW, Sitzungsb. Ges. Naturf. Freunde Berlin, 1876, p. 73. (New Hanover.)

Admiralty Islands: Ponam Islet (north of Manus Island)—1 male, August 13.

The specimen was molting body feathers when collected.

EDOLISOMA TENUIROSTRE ADMIRALITATIS Rothschild and Hartert

Edolisoma amboinense admiralitatis ROTHSCHILD AND HARTERT, Bull. Brit. Orn. Club, vol. 33, 1914, p. 108. (Admiralty Islands.)

Admiralty Islands: Manus Island—Lorengau, 1 male, 1 unsexed, August 18, 19.

The two birds were in molt when collected.

APLONIS METALLICUS NITIDUS (G. R. Gray)

Calornis nitida G. R. GRAY, Proc. Zool. Soc. London, 1858, p. 181. (New Ireland.)

St. Matthias Islands: Mussau Island—Schadel Bay, 1 male, August 25.

MYZOMELA NIGRITA HADES Meise

Myzomela nigrita hades MEISE, Ornith. Monatsb., vol. 37, 1929, p. 84. (St. Matthias Islands.)

St. Matthias Islands: Mussau Island—Schadel Bay, 1 female, August 25.

MYZOMELA NIGRITA PAMMELAENA Sclater

Myzomela pammelaena SCLATER, Proc. Zool. Soc. London, 1877, p. 553. (Admiralty Islands.)

Admiralty Islands: Ponam Islet (north of Manus Island)—1 unsexed (alcoholic), August 13.

BIRDS COLLECTED AT SAMAR, PHILIPPINE ISLANDS

The party of Johnson, Wharton, Muennink, Necker, Fritts, and Carver was attached to the United States Naval Station at Guiuan, Samar Island, during the period from February 28 to March 20, 1945. Guiuan is located near the end of a narrow peninsula extending from the southeastern part of the island. The region where birds were collected consists of forested country broken by outcroppings of rough coral rock. Much of the area is planted with coconut palms and contains brushy undercover.

BUTASTUR INDICUS (Gmelin)

Falco indicus GMELIN, Syst. Nat., vol. 1, pt. 1, 1788, p. 264. (Java, *ex* Latham.)

1 juvenile male, 1 female, March 5, 18.

GALLUS GALLUS GALLUS (Linnaeus)

Phasianus Gallus LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 158. ("India orientali, Pouli candor etc." Restricted type locality, Island of Pulo Condor, off the mouths of the Mekong.)

1 female, March 8.

PHAPITRERON LEUCOTIS ALBIFRONS McGregor

Phapitreron albifrons McGREGOR, Philippine Journ. Sci., vol. 2, sect. A, 1907, p. 317. (Tagbilaran, Bohol, Philippine Islands.)

1 male, March 14.

This specimen has been compared with birds from Samar and Bohol including the type of *P. samarensis* Mearns, which has been assigned to this race by Peters (Checklist Birds of the World, vol. 3, 1937, p. 24).

CENTROPUS VIRIDIS VIRIDIS (Scopoli)

Cuculus viridis SCOPOLI, Del. Flor. et Faun. Insubr., fasc. 2, 1786, p. 89. (Antigua, Panay, Philippine Islands, *ex* Sonnerat.)

2 males, March 7, 17.

Birds were found in brushy vegetation.

COLLOCALIA TROGLODYTES G. R. Gray

Collocalia troglodytes G. R. GRAY, Gen. Birds, vol. 1, 1845, p. [55] (nomen nudum), col. pl. XIX. (No locality = Philippine Islands.)

2 males, March 12.

Swiftlets were abundant in the vicinity of Guiuan.

HALCYON SMYRNENSIS GULARIS (Kuhl)

Alcedo Gularis KUHL, Buffoni et Daubentoni Fig. Av. Col. Nom. Syst., 1820, p. 4. (Madagascar, *ex* Pl. Col., No. 232, error = Philippine Islands.)

1 female, March 12.

This kingfisher was apparently rare at Guiuan; only this one bird was seen.

HALCYON CHLORIS COLLARIS (Scopoli)

Alcedo collaris SCOPOLI, Del. Flor. et Faun. Insubr., fasc. 2, 1786, p. 90. (No locality = Philippine Islands, *ex* Sonnerat, Voyage a la Nouvelle Guinée, 1776, p. 67, pl. 33; restricted to Manila, Island of Luzon, by Oberholser, 1919.)

6 males, 3 females, February 27, March 1, 5, 6, 9, 18.

This kingfisher was rather numerous in the vicinity of Guiuan.

EURYSTOMUS ORIENTALIS ORIENTALIS (Linnaeus)

Coracias orientalis LINNAEUS, Syst. Nat., ed. 12, vol. 1, 1766, p. 159. ("India orientali" = Java, *apud* Stresemann.)

1 male, 1 female, March 11, 12.

ORIOLUS CHINENSIS CHINENSIS Linnaeus

Oriolus chinensis LINNAEUS, Syst. Nat., ed. 12, vol. 1, 1766, p. 160. (China.)

2 males, 1 female, March 3, 5, 18.

Small groups of these birds were found in coconut groves.

CORVUS CORONOIDES PHILIPPINUS Bonaparte

Corvus philippinus BONAPARTE, Compt. Rend. Acad. Sci. Paris, vol. 37, 1853, p. 830. (Philippine Islands.)

2 males, March 2, 18.

Crows were frequently observed in the forested areas and along the air strip at Guiuan.

MICROSCELIS GULARIS GULARIS (Pucheran)

Philemon gularis PUCHERAN, *in* "Cuvier," Arch. Mus. d'Hist. Nat., vol. 7, 1855, p. 344, pl. 18. (China, error = Luzon.)

2 males, 2 females, March 6, 8, 14.

Birds were found in brushy undercover in the coconut groves.

PYCNONOTUS GOIAVIER GOIAVIER (Scopoli)

Muscicapa goiavier SCOPOLI, Del. Flor. et Faun. Insubr., fasc. 2, 1786, p. 96. (Manila, Philippine Islands, *ex* Sonnerat.)

3 males, 1 female, March 1, 3, 14.

Birds were numerous in brushy areas.

HYPOTHYMIS AZUREA AZUREA (Boddaert)

Muscicapa azurea BODDAERT, Tabl. Pl. Enl., 1783, p. 41. (Philippine Islands, *ex* Daubenton, restricted type locality, Luzon, Peters, 1939.)

1 male, March 6.

LANIUS CRISTATUS LUCIONENSIS Linnaeus

Lanius lucionensis LINNAEUS, Syst. Nat., ed. 12, vol. 1, 1766, p. 135. (Insula Lucionensi = Luzon.)

2 juvenile males, 1 juvenile female, March 6, 14, 18.

NECTARINIA JUGULARIS JUGULARIS (Linnaeus)

Certhia jugularis LINNAEUS, Syst. Nat., ed. 12, 1766, p. 185. ("In Philippinis" = Philippine Islands.)

2 males, 1 female, March 9, 14.

Birds were found in the mangrove swamps.

BIRDS COLLECTED AT OKINAWA, RIU KIU ISLANDS

A party from the Unit went to Okinawa with the invasion forces, landing on the island on April 13, 1945. Markley represented the Laboratory of Mammalogy and worked with Hardcastle and Posekany of the Laboratory of Acarology on field studies. Collections were made by Markley chiefly in the region of Nago (see fig. 4). Specimens were often obtained under hazardous conditions during the fighting between American and Japanese forces. Markley returned to Guam on June 15. Muennink went to Okinawa on July 15 and was joined by Johnson on August 30. Most of the birds collected by Johnson and Muennink were taken in the northern and central parts of the island. A few off-shore islets were also visited. They returned to Guam on October 2.

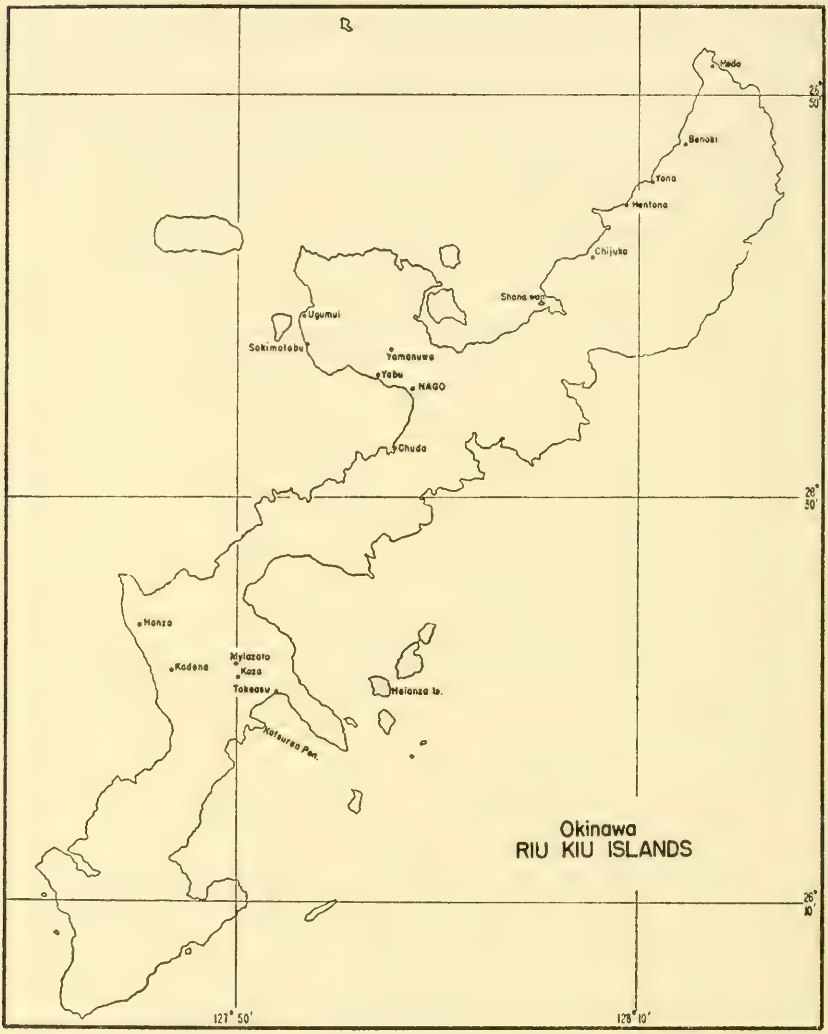


FIG. 4.—Collecting localities on Okinawa.

BUTORIDES STRIATUS AMURENSIS Schrenck

Ardea (*Butorides*) *virescens* var. *amurensis* SCHRENCK, Reise Amur Lande, vol. 1, pt. 2, 1860, p. 441. (Amurland.)

Hentona—1 female, September 11.

Birds were observed in trees along rocky streams.

EGRETTA GARZETTA GARZETTA (Linnaeus)

Ardea Garzetta LINNAEUS, Syst. Nat., ed. 12, vol. 1, 1766, p. 237. ("Oriente," *ex* Brisson.)

Heianza Shima—1 female, August 2.

The specimen was molting wing feathers when shot.

DEMIGRETTA SACRA SACRA (Gmelin)

Ardea sacra GMELIN, Syst. Nat., vol. 1, pt. 2, 1789, p. 640. (Tahiti.)

Heianza Shima—1 unsexed juvenile (gray phase), August 4; Benoki—1 female (gray phase), September 26.

Birds in both gray and white phase were seen on beaches.

IXOBRYCHUS SINENSIS SINENSIS (Gmelin)

Ardea Sinensis GMELIN, Syst. Nat., vol. 1, pt. 2, 1789, p. 642. ("Sina = China.)

Hentona—1 male, 1 juvenile male, August 9, 31.

IXOBRYCHUS CINNAMOMEUS (Gmelin)

Ardea cinnamomea GMELIN, Syst. Nat., vol. 1, pt. 2, 1789, p. 643. ("Sina" = China.)

Nago—1 male, May 2; Kashuren-Wan—1 male, June 7; Hentona—2 males, 1 juvenile male, August 17, 31, September 19.

The birds were collected in rice fields. They were more abundant than *I. s. sinensis.*

ANAS POECILORHYNCHA ZONORHYNCHA Swinhoe

Anas zonorhyncha SWINHOE, Ibis, 1866, p. 394. (Ningpo, China.)

Hentona—1 male, August 13.

TURNIX SUSCITATOR OKINAVENSIS Phillips

Turnix suscitator okinavensis PHILLIPS, Auk, vol. 64, 1947, p. 126. (Okinawa, Riu Kiu Islands.)

Kashuren-Wan—1 male, June 7.

The characters of this specimen agree with those used by Phillips in his recent description of the button quail from the southern and central Riu Kiu Islands. In comparison with male birds of the subspecies *T. s. blakistoni* from Tonkin (September) and from Cochinchina (March), this male from Okinawa is paler with fewer black markings on the upper parts and breast, and has a slightly shorter wing and a slightly shorter and heavier bill.

Markley observed quail in open grasslands, in fallow fields, and at the edges of deserted villages. The specimen obtained was molting its wing feathers.

GALLINULA CHLOROPUS INDICA Blyth

Gallinula chloropus ? var. *Indicus* Blyth, Journ. Asiatic Soc. Bengal, vol. 11, 1842, p. 887. (Calcutta.)

Nago—1 male, 1 female, May 5; Heianza Shima—1 male, August 1; Hentona—1 male, 1 female, 4 juvenile males, 2 juvenile females, August 13, 31.

Gallinules were collected in rice fields. Specimens resemble closely birds from China, Siam, and India.

ROSTRATULA BENGHALENSIS BENGHALENSIS (Linnaeus)

Rallus benghalensis Linnaeus, Syst. Nat., ed. 10, vol. 1, 1758, p. 153. (Asia.)

Takeasu—1 female, May 15.

This bird was collected by B. V. Travis in a rice paddy.

CHARADRIUS LESCHENAULTII Lesson

Charadrius Leschenaultii Lesson, Dict. Sci. Nat., éd. Levrault, vol. 42, 1826, p. 36. (Pondichery, India.)

Heianza Shima—1 male, 1 female, July 30.

NUMENIUS ARQUATA ORIENTALIS C. L. Brehm

Numenius orientalis C. L. Brehm, Handb. Naturg. Vögel Deutschl., 1831, p. 610. (East Indies.)

Heianza Shima—1 female, August 2.

TRINGA NEBULARIA (Gunnerus)

Scolopax nebularia Gunnerus, *in* Leem. Beskr. Finm. Lapper, 1767, p. 251. (District of Trondhjem, Norway.)

Heianza Shima—1 male, July 31.

ACTITIS HYPOLEUCOS (Linnaeus)

Tringa Hypoleucos Linnaeus, Syst. Nat., ed. 10, vol. 1, 1758, p. 149. (Europe, restricted type locality, Sweden.)

Hentona—1 male, 1 female, August 24, September 3.

HETEROSCELUS INCANUS BREVIPES (Vieillot)

Totanus brevipes Vieillot, Nouv. Dict. Hist. Nat., vol. 6, 1816, p. 410. (No locality given; the type is from Timor.)

Chuda—1 male, 1 female, May 5; Heianza Shima—1 female, July 30; Hentona—1 female, 1 unsexed, September 8.

The birds collected in May and July are in nuptial plumage. The birds taken in September are in winter plumage.

GALLINAGO MEGALA Swinhoe

Gallinago megala Swinhoe, Ibis, 1861, p. 343. (Between Takoo and Peking, China.)

Hentona—1 male, 3 females, August 9, 31.

Birds were collected in rice fields.

STERNA ALBIFRONS SINENSIS Gmelin

Sterna sinensis Gmelin, Syst. Nat., vol. 1, pt. 2, 1789, p. 608. ("Sina" = China, *ex* Latham.)

Heianza Shima—1 male, July 30.

STERNA SUMATRANA SUMATRANA Raffles

Sterna Sumatrana Raffles, Trans. Linn. Soc. London, vol. 13, pt. 2, 1822, p. 329. (Sumatra.)

Heianza Shima—1 male, 1 female, July 31.

STERNA DOUGALLII BANGSI Mathews

Sterna dougallii bangsi Mathews, Birds of Australia, vol. 2, 1912, p. 364 (Foochow, China.)

Heianza Shima—1 unsexed, July 26.

ANOÜS STOLIDUS PILEATUS (Scopoli)

Sterna pileata Scopoli, Del. Flor. et Faun. Insubr., fasc. 2, 1786, p. 92. (No locality = Philippines, *ex* Sonnerat.)

Benoki—1 juvenile female, September 17; Hentona—1 juvenile female, September 17.

The noddy terns were collected on the coast following a 2-day typhoon. When taken, the specimens appeared exhausted and in poor physical condition. These were the only noddy terns seen.

COLUMBA JANTHINA JANTHINA Temminck

Columba janthina TEMMINCK, Pl. Col., livr. 86, 1830, pl. 503. (Japan.)

Hedo—1 female, September 26.

One flock of these pigeons was seen at Hedo.

STREPTOPELIA ORIENTALIS STIMPSONI (Stejneger)

Turtur stimpsoni STEJNEGER, Proc. U. S. Nat. Mus., vol. 10, 1887, p. 399. (Riu Kiu Islands, Japan.)

Nago—1 male, May 1; Yamanuwa—1 male, May 22; Chijuka—1 female, August 19; Hentona—1 female, August 31; Hedo—1 female, September 29.

CUCULUS POLIOCEPHALUS POLIOCEPHALUS Latham

Cuculus poliocephalus LATHAM, Index Orn., vol. 1, 1790, p. 214. (India.)

Hedo—1 female, September 29.

The cuckoo was observed in hilly areas.

OTUS BAKKAMOENA PRYERI (Gurney)

Scops pryeri GURNEY, Ibis, 1889, p. 302. (Okinawasima, Riu Kiu Islands.)

Hedo—1 juvenile male, August 26.

Owls were observed in pine trees near villages.

ALCEDO ATTHIS JAPONICA Bonaparte

Alcedo japonica BONAPARTE, Ateneo Italiano, No. 11, 1854, p. 320. (Japan.)

Nago—1 male, May 4; Kadena—2 unsexed juveniles, May 29; Heianza Shima—1 male, 1 female, July 31, August 1; Chijuka—1 unsexed, August 19; Hentona—1 male, August 21.

Kingfishers were common along the lower parts of streams. The birds are similar to specimens from Japan in the collection of the United States National Museum. Two birds taken in August were in molt.

HALCYON COROMANDA BANGSI (Oberholser)

Entomothera coromanda bangsi Oberholser, Proc. U. S. Nat. Mus., vol. 48, 1915, p. 654. (Ishigaki Island, Riu Kiu Islands.)

Nago—1 male, May 18; Koza—1 male, June 6; Hedo—1 juvenile male, September 2; Benoki—1 juvenile male, August 22; Shana-Wan—1 male, September 13.

Birds were found in forested areas.

SAPHEOPIPO NOGUCHII (Seebohm)

Picus noguchii Seebohm, Ibis, 1887, p. 178. (Loo-choo Islands = Riu Kiu Islands.)

Hedo—2 females, September 2, 29.

The two birds were collected in dense forest near Hedo. They are secretive birds and appear to be rare. The female taken September 29 was in molt. Apparently one bird has been incorrectly sexed; it has the plumage of a male.

DRYOBATES KIZUKI NIGRESCENS (Seebohm)

Iyngipicus kizuki nigrescens Seebohm, Ibis, 1887, p. 177. (Loo-choo Islands = Riu Kiu Islands.)

Hedo—1 male, September 26.

This woodpecker was collected in a pine tree in thick forest. It was molting wing and body feathers.

HIRUNDO TAHITICA NAMIYEI (Stejneger)

Chelidon namiyei Stejneger, Proc. U. S. Nat. Mus., vol. 9, 1886 (1887), p. 646. (Okinawa Shima.)

Hanza—1 unsexed juvenile, June 6; Hentona—1 male, 1 juvenile male, August 18; Hedo—1 juvenile male, August 31.

PERICROCOTUS ROSEUS TEGIMAE Stejneger

Pericrocotus tegimae Stejneger, Proc. U. S. Nat. Mus., vol. 9, 1886 (1887), p. 648. (Okinawa Shima.)

Hedo—1 male, 1 female, September 26.

The two birds were in molt when collected.

CORVUS CORONOIDES CONNECTENS Stresemann

Corvus coronoides connectens STRESEMANN, Verh. Orn. Ges. Bayern, vol. 7, 1916, p. 281. (Miyakojima.)

Yabu—1 female, May 21; Hedo—2 juvenile males, August 31, September 26; Hentona—1 male, 2 juvenile males, May 15, August 11.

The adult male measures: wing 325, tail 220, full culmen 58.2, depth of bill at nostril 22.4; the adult female, 332, 229, 63.1, 21.7. Three of the juveniles (August and September) measure: wing 303-306, full culmen 55.1-61.6, depth of bill at nostril 20.1-22.4. The fourth juvenile male (May) measures 272, 54.6, 20.8. This latter bird might be an example of the smaller *C. c. osai* Agawa (Kuroda, Avifauna Riu Kiu Ids., 1925, p. 2), but it is not in a condition to be identified as to subspecies.

PARUS MAJOR OKINAWAE Hartert

Parus major okinawae HARTERT, Vögel Pal. Faun., vol. 1, 1905, p. 346. (Okinawa Island, Northern Riu Kiu Group.)

Yona—1 male, August 21; Chijuka—1 male, September 18.

Birds were found singly or in pairs in marginal brushlands.

MICROSCELIS AMAUROTIS PRYERI (Stejneger)

Hypsipetes pryeri STEJNEGER, Proc. U. S. Nat. Mus., vol. 9, 1886 (1887), p. 642. (Okinawa Shima.)

Yamanuwa—1 female, May 17; Hanza—1 unsexed, June 6; Koza—1 unsexed, June 6; Hedo—2 juvenile males, 1 unsexed juvenile, August 28, 31, September 3.

The naval field party reported that these birds, especially the juveniles, were numerous during August and September.

LUSCINIA KOMADORI NAMIYEI (Stejneger)

Icoturus namiyei STEJNEGER, Proc. U. S. Nat. Mus., vol. 9, 1886 (1887), p. 644. (Okinawa Shima.)

Chijuka—2 males, 1 female, September 18; Hentona—1 female, September 20.

Birds were found in dense cover in hilly areas, usually along streams. All the specimens were in molt when collected.

MONTICOLA SOLITARIUS MAGNUS (La Touche)

Petrophila solitaria magna La Touche, Bull. Brit. Orn. Club, vol. 40, 1920, p. 97. (Japan.)

Yamanuwa—1 male, 1 female, 1 unsexed, May 15, 19; Ogumui—1 male, May 13; Sakimotobu—1 unsexed, May 13; Hentona—5 females, 7 juvenile males, 2 unsexed, August 4, 9, 20, 21, 24, 26, 27, 31, September 20.

Birds were collected in rocky areas along the coast. Two of the birds taken in August were in molt.

CISTICOLA JUNCIDIS BRUNNICEPS (Temminck and Schlegel)

Salicaria (*Cisticola*) *brunniceps* Temminck and Schlegel, *in* Siebold's Faun. Japon., Aves, 1850, p. 134, pl. 20. (Japan.)

Nago—1 male, May 2; Myazato—1 unsexed, May 16; Kashuren-Wan—1 female, June 7; Yona—1 juvenile female, 2 unsexed juveniles, August 26; Hentona—1 juvenile female, 1 fledgling, August 18, September 19.

Birds were collected in fallow fields.

PHYLLOSCOPUS BOREALIS XANTHODRYAS Swinhoe

Phylloscopus xanthodryas Swinhoe, Proc. Zool. Soc. London, 1863, p. 296. (Amoy.)

Hedo—2 unsexed, September 26, 29.

Birds were observed in woodland areas. They were not seen in late August.

PHYLLOSCOPUS BOREALIS BOREALIS (Blasius)

Phyllopneuste borealis Blasius, Naumannia, 1858, p. 313. (Sea of Ochatsk.)

Hedo—1 juvenile female, September 29.

HEMICHELIDON GRISEISTICTA GRISEISTICTA Swinhoe

Hemichelidon griseisticta Swinhoe, Ibis, 1861, p. 330. (Amoy and Takoo.)

Hentona—1 male, September 25; Hedo—3 males, 1 juvenile male, 2 unsexed, September 26, 29.

These birds have been compared with the type of *H. g. pallens* (Stejneger) and with specimens of *H. g. habereri* Parrot. The wings of the adults measure 81-83.

TERPSIPHONE ATROCAUDATA ILLEX Bangs

Terpsiphone illex Bangs, Bull. Mus. Comp. Zool., vol. 36, 1901, p. 264. (Ishigaki, Southern Liu Kiu Group.)

Nago—1 male, May 15; Hedo—1 juvenile male, 1 unsexed, September 3, 26.

The adult specimen, taken by Markley in May, is in breeding plumage.

MOTACILLA CINEREA CASPICA (S. G. Gmelin)

Parus Caspicus S. G. Gmelin, Reise durch Russland, vol. 3, 1774, p. 104, pl. 20, fig. 2. (Enzeli on the Caspian Sea.)

Hedo—1 female, 1 unsexed, August 26, September 26; Yona—1 unsexed, September 3.

ZOSTEROPS PALPEBROSA LOOCHOOENSIS Tristram

Zosterops simplex var. *loochooensis* Tristram, Ibis, 1889, p. 229. (Loo-choo Islands=Riu Kiu Islands.)

Kadena—2 females, May 29; Hedo—2 unsexed, September 26, 29.

Small flocks were found in brushy areas. One bird taken in September was in molt.

PASSER MONTANUS SATURATUS Stejneger

Passer saturatus Stejneger, Proc. U. S. Nat. Mus., vol. 8, 1885, p. 19. (Liu Kiu Islands, Japan.)

Hentona—1 female, August 17.

Birds were found in villages.

BIRDS COLLECTED AT IWO JIMA, VOLCANO ISLANDS

Wharton visited Iwo Jima from March 27 to 31, 1945. He reported finding only five kinds of birds. The fighting during the invasion of the island destroyed or damaged much of the available habitat for land birds (pl. 1).

PLUVIALIS DOMINICA FULVA (Gmelin)

Charadrius fulvus Gmelin, Syst. Nat., vol. 1, pt. 2, 1789, p. 687. (Tahiti.)

1 male, March 27.

Wharton reported seeing several flocks of these plovers. The specimen obtained was in prenuptial molt.

MICROSCELIS AMAUROTIS MAGNIROSTRIS (Hartert)

Hypsipetes amaurotis magnirostris HARTERT, Bull. Brit. Orn. Club, vol. 15, 1905, p. 46. (S. Dionisio, Volcano Islands.)

3 females, March 30.

One specimen had a healing wound on the tarsus when collected. Another was in molt.

MONTICOLA SOLITARIUS MAGNUS (La Touche)

Petrophila solitaria magna LA TOUCHE, Bull. Brit. Orn. Club, vol. 40, 1920, p. 97. (Japan.)

3 males, 2 females, March 29, 30.

Wharton found these birds in scrub vegetation. One specimen has a broken foot, which apparently was healing when obtained. One male was in molt when shot. The specimens are in worn plumage but to me are subspecifically indistinguishable from birds from Japan, Korea, and Okinawa.

ZOSTEROPS PALPEBROSA ALANI Hartert

Zosterops palpebrosa alani HARTERT, Bull. Brit. Orn. Club, vol. 15, 1905, p. 45. (S. Dionisio, Volcano Islands.)

2 males, March 30.

Wharton found the white-eyes in woody cover.

BIRDS COLLECTED IN MICRONESIA

Field parties visited some of the American-held bases in the Mariana, Caroline, and Palau Islands during the period from May to December, 1945. Owing to the similarity of the birdlife on these islands, a single report for the entire area is made.

On Guam, collections were made from January to November. Most parts of the island were visited (fig. 5) with the exception of the interior of the southern part.

On Rota, a party consisting of Johnson, Markley, Necker, Fritts, and C. A. Woodbury collected from October 17 to November 2. Localities are shown on the map, figure 6.

The writer, together with Davison, McElroy, and Joseph N. Strong, collected on Ulithi Atoll during the period from August 11 to August 23. As shown in figure 7, the islands visited included Asor, Falalop, Potangeras, Pau, Bulubul, Losiep, Mangejang, and Fassarai. Except for Asor and Falalop (pl. 2, fig. 1), which were partially cleared for service installations, most of the islands are practically undisturbed.

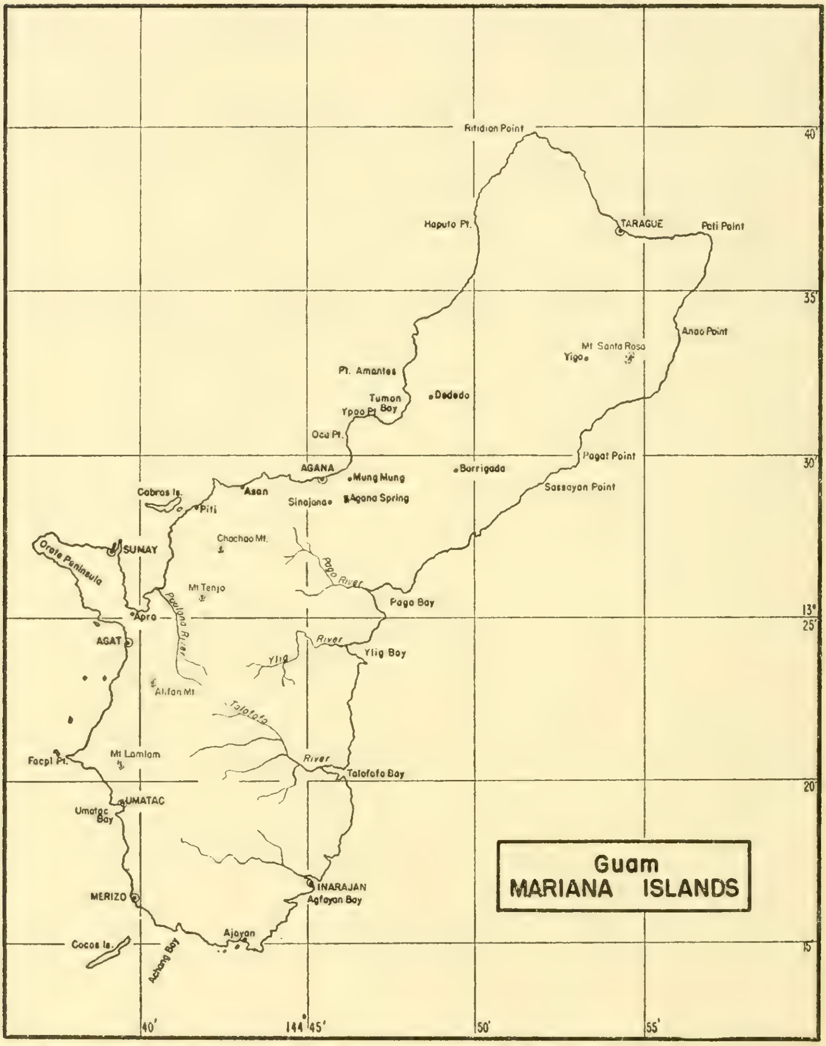


FIG. 5.—Collecting localities on Guam Island.

McElroy visited Truk Atoll from November 24 to December 18. Collections were made on Moen Island, and observations were made on Dublon, Fefan and Udot, shown by the map, figure 8. Most of the bird skins were lost in shipment; only six specimens were saved.

Davison, McElroy, Strong, and the writer collected on American-held islands in the southern Palaus from August 24 to September 24.

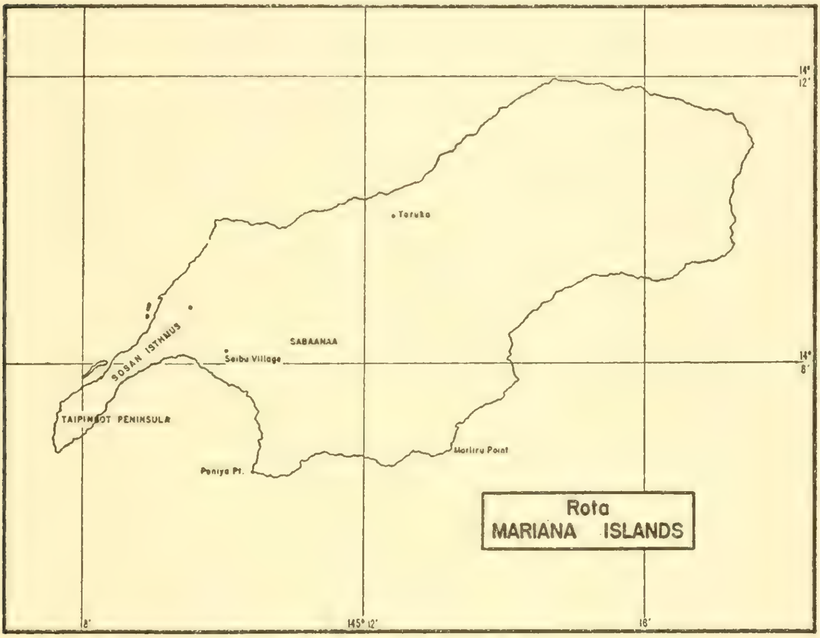


FIG. 6.—Collecting localities on Rota Island.

As shown in figure 9, the islands of Peleliu, Angaur, Ngabad, Ngesebus, Garakayo, and Kayangel were visited.

PUFFINUS LHERMINIERI DICHROUS Finsch and Hartlaub

Puffinus dichrous FINSCH AND HARTLAUB, Fauna Centralpolynesia, 1867, p. 244. (McKean Island, Phoenix group.)

Several shearwaters, presumably this form, were seen during a voyage from Peleliu to the Kayangel Islands of the Palau group on September 2. Most of the birds were observed a few miles offshore from the large island of Babelthuap.

PHAËTHON LEPTURUS DOROTHEAE Mathews

Phaethon lepturus dorotheae MATHEWS, Austr. Av. Rec., vol. 2, 1913, p. 7. (Queensland.)

Guam Island: Amantes Point—5 males, June 11, July 21. Palau Islands (Peleliu Island): 1 mi. north of Asias—1 male, August 31; Eastern Peninsula—1 male, September 6; Southeastern Peninsula—2 males, 1 female, August 29, September 1, 5.

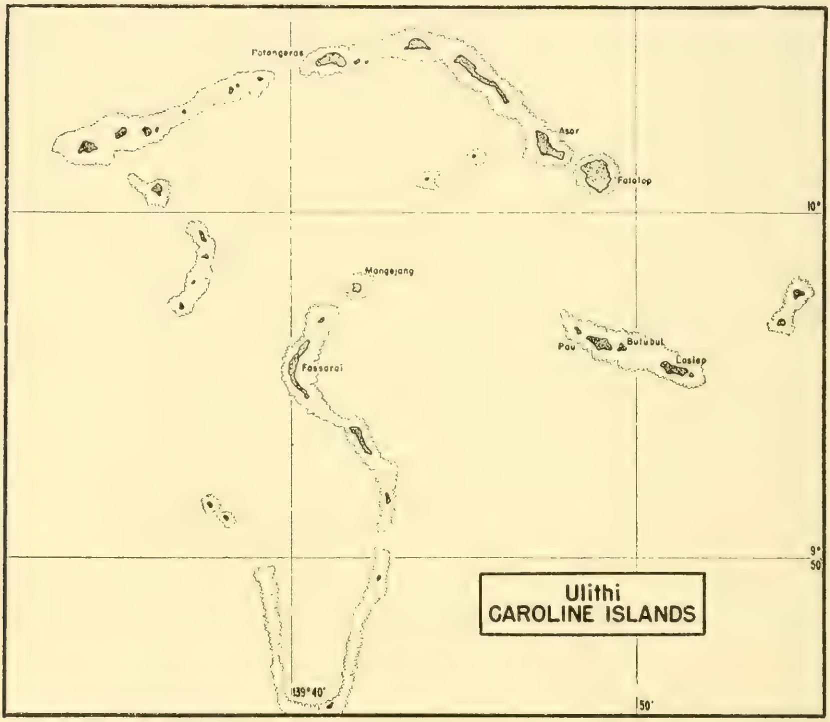


FIG. 7.—Collecting localities on Ulithi Atoll.

Tropic-birds were seen at Guam, Rota, Peleliu, and Truk. Service personnel reported their presence at Ulithi, but none was observed in August by our party.

	Wing	Tail	Exposed culmen	Tarsus
5 adult males (Guam)	256-265 (262)	101-117 (109)	44-50 (47)	20-21 (21)
4 adult males (Peleliu)	242-258 (252)	106-122 (111)	40-46 (44)	19-20 (20)
1 adult female (Peleliu)	260	118	43	20

The average measurements of the 10 adult specimens from Micronesia are within the range of measurements given by Mathews for

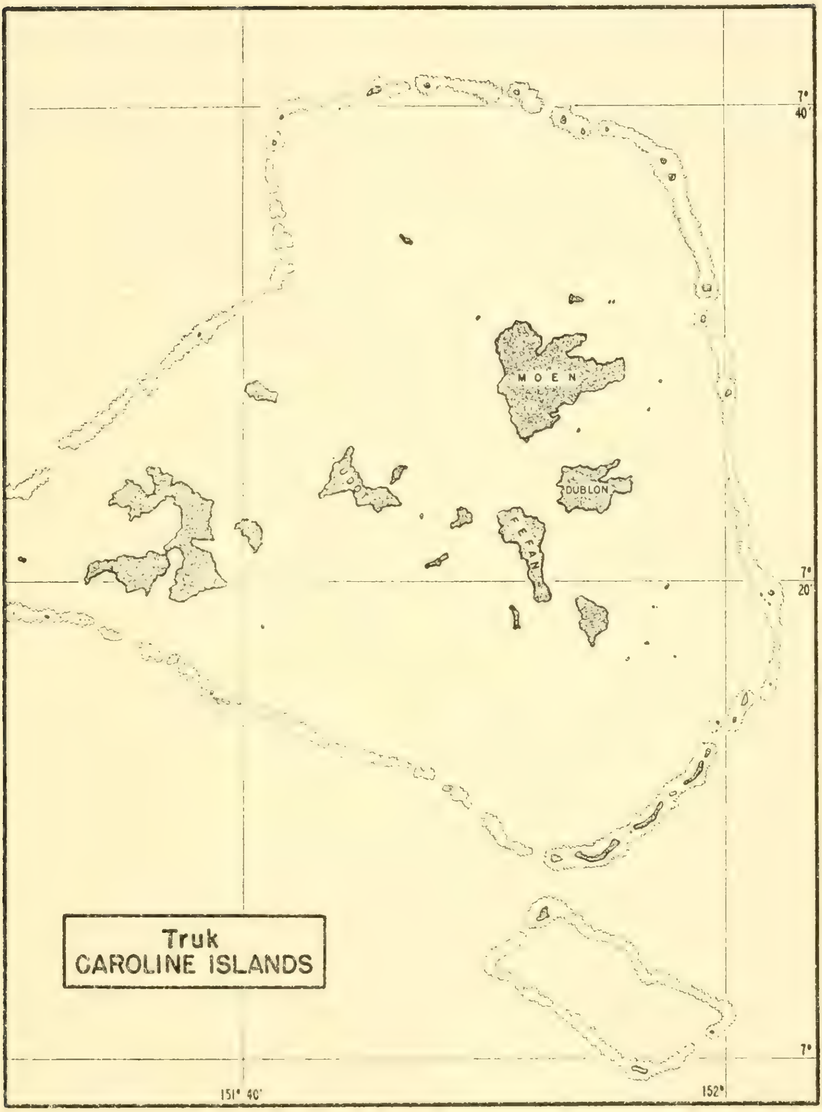


FIG. 8.—Truk Atoll, Caroline Islands.

Pacific birds (Birds of Australia, 1915, vol. 4, p. 309). In comparing the male birds from Guam and Peleliu, the former ones are larger in appearance and in wing and culmen length. These specimens are probably representatives of breeding populations, and it is quite possible that such breeding populations at different islands might show some size variations. All the birds appear to be in good physical condition. Two of the birds from Peleliu were growing the elongated

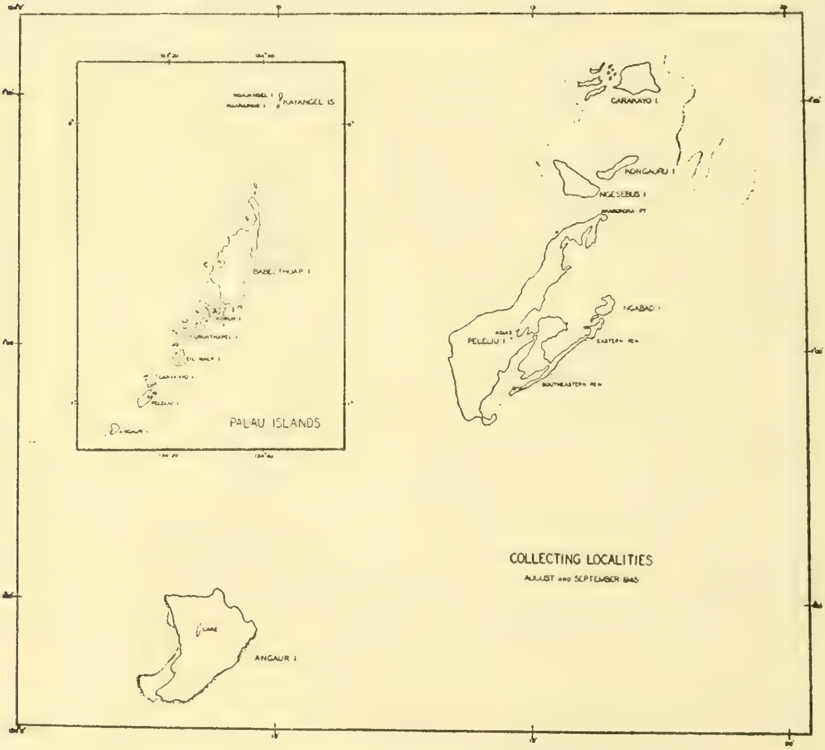


FIG. 9.—Collecting localities in the Palau Islands.

central tail plumes when collected. Weights of the five males from Guam: 267-321 (294).

At Guam, tropic-birds were seen at three localities, each of these being high, rugged, coastal cliffs: Amantes Point, Anao Point, and Orote Peninsula. Most of the birds were observed at Amantes Point, where 20 individuals were counted on May 24 flying in and out of large fissures located about 250 feet above the beach. This place was visited several times from May to July, and birds were seen on each occasion. It was not discovered whether the birds were nesting; however, four males taken on June 11 had enlarged testes.

At Peleliu, tropic-birds were more numerous than at Guam and occurred in all parts of the island, in jungle areas and at cliffs. Birds were nesting in August and September. Nests were observed in hollows of the Australian pine (*Casuarina equisetifolia*), between 20 and 30 feet from the ground. Nesting birds were easily found, since their long tail feathers could be seen extending from the hollows. One nest was observed in a dead tree in a cleared battle area; others were in trees surrounded by jungle vegetation (pl. 2, fig. 2). One male (September) had enlarged testes. Stomachs of birds collected contained small fish.

At Truk, McElroy found tropic-birds at the high cliffs on Moen Island in November and December.

SULA LEUCOGASTER PLOTUS (Forster)

Pelecanus Plotus FORSTER, Descr. Anim., ed. Licht., 1844, p. 278. (near New Caledonia.)

Rota Island: Taipingot Peninsula—1 male, 1 female, 1 juvenile female, October 24.

At Rota, 12 brown boobies were seen by Johnson at the high cliffs on Taipingot Peninsula on October 24. The juvenile female weighed 1,042 grams. The adult male was in molt. Birds were seen at Guam flying near cliffs and offshore in May, July, and November. At Truk, one bird was recorded at Udot Island in December.

PHALACROCORAX MELANOLEUCOS MELANOLEUCOS (Vieillot)

Hydrocorax melanoleucos VIEILLOT, Nouv. Dict. Hist. Nat., vol. 8, 1817, p. 88. ("Australasie," restricted type locality, New South Wales, *fide* Mathews.)

Palau Islands (Peleliu Island): Akarakoro Point—2 females, 2 juvenile females, September 7, 16; Asias—1 juvenile female, August 27; Eastern Peninsula—1 female, September 10.

Measurements of two adult females are: wing 220 and 222, tail 153 and 157, culmen from notch of the suture between the maxilla and the quadratojugal bones 35 and 36. These measurements are within the range of those given by Amadon (Amer. Mus. Novit., No. 1175, 1942, pp. 1-2).

On islands of the southern Palaus visited by our field party, the cormorant was found in mangrove swamps (pl. 3, fig. 1), The birds were occasionally observed in groups of 10 or more individuals. They were sluggish birds and could be approached easily. Stomachs contained fish. There was no indication of breeding during August and September. Most of the birds had worn or molting plumage when collected.

DEMIGRETTA SACRA SACRA (Gmelin)

Ardea sacra Gmelin, Syst. Nat., vol. 1, pt. 2, 1789, p. 640. (Tahiti.)

Guam Island: Gray phase, Ypao Point—2 males, July 6, August 8; Oca Point—1 juvenile female, May 11; Ylig Bay—1 female, July 24; Facpi Point—2 juvenile males, July 27; Agfayan Bay—3 females, June 6, July 8; Port Ajayan—3 males, June 18, July 16; Achang Bay—1 juvenile male, 2 females, July 16, August 6, 27; no locality—1 juvenile male, September. White phase, Agfayan Bay—1 male, June 6; Port Ajayan—1 male, June 18. Mottled immatures, Port Ajayan—1 male, June 18; Achang Bay—2 males, July 16. Rota Island: Gray phase, Sosan Isthmus—1 male, 1 female, 1 juvenile male, October 18, November 2, 5. Ulithi Atoll: White phase, Potangeras Island—1 female, August 15. Palau Islands (Peleliu Island): Gray phase, Eastern Peninsula—1 female, 1 juvenile male, September 10. White phase, Akarakoro Point—1 female, September 16.

Of 29 reef herons collected in Micronesia, 21 were in gray phase, 4 in white phase and 4 were mottled juveniles. Field observations, however, showed a ratio of about 6 grays to 4 whites, which agrees with the findings of Mayr and Amadon (Amer. Mus. Novit., No. 1144, 1941, p. 8). Birds were seen as follows: Guam, about 6 grays to 4 whites; Rota, no white herons seen; Ulithi, 4 grays, 6 whites, 1 mottled; Truk, 1 gray, 2 whites, 1 mottled; Palau, equal numbers of gray and white. No adult mottled herons were collected.

Weights of four adult males from Guam (gray phase) are 590-667 (614), of two adult males from Guam (white phase) 600 and 662, of five adult females from Guam and Rota (gray phase) 477-553 (506). Birds lacking ornamental plumes, and probably all juveniles, were taken in the summer months. One specimen taken in June was in molt and most of those birds collected later in the year were also in molt. Stomachs examined contained fish and crabs.

EGRETTA INTERMEDIA INTERMEDIA (Wagler)

Ardea intermedia Wagler, Isis, 1829, p. 659. (Java.)

Guam Island: Piti—2 males, June 13. Rota Island: Taruka—1 male, October 31. Ulithi Atoll: Potangeras Island—1 female, August 15. Palau Islands: Angaur Island—1 male, 1 female, September 21.

The egret has been reported as a winter visitor to Koror in the Palau Islands (Handlist Japanese Birds, 3rd ed., 1942, p. 203). These records extend the range of this bird to the Carolines and Marianas. The specimens collected in Micronesia were nonbreeding birds, all of them having yellow bills tipped with black. Birds taken at Guam in June and at Angaur in September show no development of ornamental plumes, whereas birds taken at Ulithi in August and at Rota in late October have some ornamental plumes.

At Guam, the egret was first observed on February 25, when a group of 14 birds was seen in a fallow rice paddy near Piti. The flock remained in this vicinity and was observed until June 13, when the area was cleared for military use. A flock of 16 birds was seen on the beach at Agfayan Bay on July 25 and again on August 6. At Ulithi, three egrets were observed feeding in grassy, cleared areas. In the Palaus, egrets were seen on tidal flats and open grassland at Angaur and Peleliu. One flock of 15 was counted. At Rota, a group of 16 birds was found in a cultivated field on October 31. On all the islands egrets appeared to prefer grassy flats to the beaches. These observations show that egrets were present in Micronesia from February through October in 1945.

Weights of two male egrets from Guam were 445 and 463. Stomachs of birds collected at Guam, Ulithi, and Angaur contained grasshoppers, other insects, spiders, and skinks.

NYCTICORAX CALEDONICUS PELEWENSIS Mathews

Nycticorax caledonicus pelewensis MATHEWS, Bull. Brit. Orn. Club, vol. 46, 1926, p. 60. (Pelew Islands.)

Palau Islands (Peleliu Island): Akarakoro Point—2 males, 2 females, September 6, 8; Southeastern Peninsula—3 females, 1 juvenile male, 1 juvenile female, 2 male nestlings, 1 female nestling, August 29, 31, September 1, 5.

Night herons were found on tidal flats and in mangrove swamps at Peleliu, Angaur, and Garakayo Islands of the Palau group. McElroy reported seeing three birds at Truk. At Southeastern Peninsula, Peleliu, two juveniles and three nestlings in postnatal molt were collected in a grove of low, saplinglike trees. There were eight nests counted in this area, all being 15 to 20 feet from the ground.

Stomachs of the birds contained eels, fish, skinks, crabs, shrimp, and insects. One stomach of an adult contained 14 large grasshoppers and four fish, totaling about 15 cc. in volume. The nestlings had insects, skinks, and eels in their stomachs. One adult taken in September was in molt.

IXOBRYCHUS SINENSIS BRYANI (Seale)

Ardetta bryani SEALE, Occ. Pap. B. P. Bishop Mus., vol. 1, No. 3, 1901, p. 27. (Guam.)

Guam Island: Pagat Point—1 female, July 10; Oca Point—1 male, August 4; Sinajana—1 unsexed, May 16; Ylig Bay—1 female, July 24; Facpi Point—1 female, July 27; Talofofo Bay—1 female, June 14; Agfayan Bay—1 male, 2 females, June 4, 6, July 8; Port Ajayan —1 male, 1 female, June 18; Achang Bay—5 males, 6 females, 1 juvenile male, June 6, 7, 19, July 16; Umatac Bay—2 males, 1 female, 1 juvenile male, 2 juvenile females, June 18.

There seems to be very little difference between these specimens and least bitterns from China and adjacent areas. Some of the adult males from Guam, taken in June and July, are paler on the back, although this may be due to wear. Adult males from Guam have a slightly longer wing and tail than those of birds from China, Siam, Okinawa, and the Philippines. Measurements of birds from Guam, *I. s. bryani,* and from China, Siam, Okinawa, and the Philippines, *I. s. sinensis* (Gmelin), are as follows:

	Wing	Tail	Full culmen	Tarsus
Ixobrychus s. bryani:				
9 adult males (Guam)...	128-138 (134)	45-50 (47)	55-60 (57)	45-47 (46)
11 adult females (Guam).	125-134 (130)	44-49 (47)	55-59 (57)	43-47 (45)
Ixobrychus s. sinensis:				
11 adult males..........	119-134 (128)	41-48 (44)	56-62 (59)	43-46 (44)

Bitterns were found on tidal flats and in fresh-water marshes at Guam. At Rota, birds were less numerous. A nest containing two eggs was collected at Achang Bay, Guam, on June 6. It was located in a cane thicket near a fallow rice field. The eggs are oval, white with a greenish cast, and measure 33 by 24 and 34 by 24. A nestling was found in thick shrubbery at Oca Point on February 1. Birds taken in June, August, and September were in molt. Weights of eight adult males from Guam are 82-103 (92), of eight adult females 84-109 (95).

IXOBRYCHUS SINENSIS MOOREI Wetmore

Ixobrychus sinensis moorei WETMORE, Bull. Mus. Comp. Zool., vol. 63, 1919, p. 173. (Uala, Truk Group, Middle Carolines.)

McElroy found bitterns in rice paddies at Truk. Specimens collected were lost in shipment. The species was apparently rare in the southern Palaus; our collecting party worked over these islands rather thoroughly and saw only one bird on September 13 at Peleliu.

I am following the Handlist of Japanese Birds, 3d ed., 1942, p. 205, in placing the Palau bittern with the race at Truk. As in the case of the race of the bittern at Guam, this form is not a very distinctive one.

ANAS SUPERCILIOSA PELEWENSIS Hartlaub and Finsch

Anas superciliosa var. *pelewensis* Hartlaub and Finsch, Proc. Zool. Soc. London, 1872, p. 108. (Pelew Islands.)

McElroy found ducks in rice paddies, marshes, and swamps at Truk. The ducks apparently flew to outlying islands during the day but roosted in the swamps of Moen Island at night. The 1942 Japanese Checklist, p. 206, places this bird in the race *Anas superciliosa rukensis* Kuroda (1939). I am unable to see a copy of this description at the present writing. The one specimen obtained was lost in shipment.

At Peleliu, service personnel reported seeing ducks, but our collecting party did not find any there in August and September.

ANAS OUSTALETI Salvadori

Anas oustaleti Salvadori, Bull. Brit. Orn. Club, vol. 4, 1894, p. 1. (Marianne Islands.)

At Guam, *Anas oustaleti* was not observed. Ducks, which might have been of this species, were seen flying over a marsh near Agat on June 13, 1945, and others were seen at a fallow rice paddy by service personnel in August 1944. It is possible that ducks are present in inland marshes and swamps of the southern interior of Guam. In June 1923 H. G. Hornbostel (in Phillips, Natural History of Ducks, vol. 2, 1923, p. 54) reported that the ducks were found only in the Talofofo River valley. Our field parties investigated the lower parts of this valley but owing to the presence of enemy troops in the area did not venture very far from the roads. Some of this area was used as an artillery range, which might have been a disturbing influence. If the ducks are present, they are apparently rather restricted in their movements.

At Rota, two ducks, which might have been of this species, were seen by Johnson on October 30 in a cultivated field. Lt. Joe T. Marshall, Jr., collected a pair of the birds at the island of Saipan in the fall of 1945. These specimens are in the collection of the United States National Museum. Ducks were also reported at a lake on Tinian. The presence of war activities and large concentrations of service personnel on the small islands inhabited by this unique bird have undoubtedly disturbed and affected the already small numbers.

This necessitates careful conservation of the ducks to insure survival, particularly in the southern Marianas.

PANDION HALIAETUS MELVILLENSIS Mathews

Pandion haliaëtus melvillensis MATHEWS, Austr. Av. Rec., vol. 1, 1912, p. 34. (Melville Island, Northern Territory.)

Records of the osprey in the southern Palau Islands in 1944 and 1945 were obtained from Lt. C. K. Dorsey of the Epidemiology Unit at Peleliu. No birds were seen during the visit of our collecting party there in August and September. An osprey was observed by Lt. B. V. Travis at Agaña Bay, Guam, in December 1945. He reported that the bird was carrying a fish in its talons.

FALCO PEREGRINUS subsp.

Lt. Irven O. Buss reported that on November 2, 1945, as his ship approached Guam, a duck hawk alighted on the superstructure. He watched the bird catch and eat a noddy tern (*Anous stolidus*) before flying to the rugged cliffs near Facpi Point.

Hawks were seen by our field parties on several occasions in the Micronesian islands. At Guam, a small hawk resembling an accipiter was observed by Muennink darting at swiftlets on Mount Tenjo on June 8. At Peleliu, a bird thought to be a duck hawk was reported in the spring of 1945. At Angaur Island on September 21, a small hawk was seen to fly into heavy vegetation at the edge of the rugged coast line.

MEGAPODIUS LAPÉROUSE SENEX Hartlaub

Megapodus senex HARTLAUB, Proc. Zool. Soc. London, 1867 (1868), p. 830. (Pelew Islands.)

Palau Islands (Peleliu Island): Southeastern Peninsula—2 males, August 31, September 1; Ngabad Island—1 female, September 11; Garakayo Island—2 males, 1 female, 1 male chick, 1 female chick, September 17, 18, 19.

At Peleliu, megapodes were found on the eastern side of the island where war activities had not removed the dense jungle cover. A few birds were also observed in the rapidly-growing vegetation that was beginning to cover the battle-cleared areas. At Garakayo Island, which was little disturbed by occupational activities, megapodes appeared rather numerous. The birds were located by listening for their loud screeches and cackles but were extremely wary and difficult to approach. The native islanders consider the birds and their eggs to be choice food. One male had enlarged testes. Stomachs contained seeds and finely ground material. A number of intestinal parasites were found.

The Mariana megapode (*Megapodius lapérouse lapérouse* Gaimard) was not found by our collecting parties on Guam or Rota. Lt. Joe T. Marshall, Jr., who collected on Tinian and Saipan in 1945, did not find the bird on those islands.

GALLUS GALLUS GALLUS (Linnaeus)

Phasianus Gallus LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 158. ("India orientali, Pouli candor etc." Restricted type locality, Island of Pulo Condor, off the mouths of the Mekong.)

Palau Islands (Peleliu Island): Eastern Peninsula—1 male, September 13; Ngabad Island—1 female, September 11; Garakayo Island—1 female, September 19.

Feral chickens were found at the Palaus, Ulithi Atoll, and Truk.

PHASIANUS TORQUATUS subsp.

On July 4, 1945, 57 ring-necked pheasants (16 cocks and 41 hens) were liberated at Guam by the United States Navy. These birds, furnished by the California Game and Fish Division, were 11 weeks old when released. Twenty-four birds were liberated at the site of CincPoa headquarters near Mount Tenjo. Thirty-three were placed near the FEA dairy farm about 1¼ miles west of the Price School. One month after release there was still evidence that birds were present, though there were reports that some had moved as far away as 1 mile. The birds were not banded.

COTURNIX CHINENSIS LINEATA (Scopoli)

Oriolus lineatus SCOPOLI, Del. Flor. et Faun. Insubr., fasc. 2, 1786, p. 87. (Luzon, Philippine Islands, *ex* Sonnerat.)

Guam Island: Mount Santa Rosa—1 male, June 28; Agat (1 mi. SE. of)—1 male, June 13.

The introduced quail frequented grassy uplands, cleared coconut groves and fallow fields on Guam. Birds were seen on Mount Tenjo, Mount Santa Rosa, near Umatac, and near Agat. They were found singly or in pairs, although a covey of seven birds was reported on Mount Tenjo. The two males, collected in June, had enlarged testes. Their weights are 34.5 and 35.5.

RALLUS PHILIPPENSIS PELEWENSIS (Mayr)

Hypotaenidia philippensis pelewensis MAYR, Amer. Mus. Novit., No. 609, 1933, p. 3. (Palau Islands.)

Palau Islands (Peleliu Island): Akarakoro Point—1 male, September 16; Asias—1 male, 2 females, August 27, 28; Garakayo Island—2 males, 1 female, 1 juvenile male, September 18, 19, 20.

Rails were collected both in swampy areas and well-drained uplands. Some birds were taken in the new growth of vines and other low vegetation of the battle areas. Stomachs contained insects, seeds, and small shells. Two males had enlarged testes.

RALLUS OWSTONI (Rothschild)

Hypotaenidia owstoni ROTHSCHILD, Nov. Zool., vol. 2, 1895, p. 481. (Guam.)

Guam Island: Ypao Point—1 male, 1 unsexed, June 28, July 14; Oca Point—1 male, 1 unsexed, 2 juvenile females, June 19, 20; Agaña—1 male, January 26; Pago River—1 female, July 23; Piti—2 males, May 8, September 8; Apra—1 juvenile female, June 30; Ylig Bay—1 female, July 19.

Rails frequented forested parts of Guam. The birds were rather secretive, many of the specimens being taken in rat traps. Black downy young were observed on April 1 and May 16. One nest containing three eggs was found in dense grass near Mount Santa Rosa on October 24. The eggs are white with a pinkish cast and a scattering of small spots of colors near "russet" and near "pearl blue" which are concentrated at the large ends. They measure 37.5 by 29.1, 39.1 by 28.0, and 40.7 by 29.0. A male, taken in January, had enlarged testes. Weights of two adult males were 256 and 257, of two adult females 210 and 252.

POLIOLIMNAS CINEREUS COLLINGWOODI Mathews

Poliolimnas cinereus collingwoodi MATHEWS, Bull. Brit. Orn. Club, vol. 46, 1926, p. 60. (New name for *ocularis* Ingram "preoccupied as a synonym of *cinereus* Vieillot.") (Philippine Islands, *ex* G. R. Gray.)

McElroy found birds in brackish swamps at Truk. One male examined in December had enlarged testes. Although recorded from many islands of Micronesia, birds were not found by our naval field parties at the other islands visited. Service personnel reported a small rail at Asor and Falalop Islands, Ulithi Atoll, in the early days of occupation, but the bird was apparently eliminated as a result of the naval activities.

GALLINULA CHLOROPUS GUAMI Hartert

Gallinula chloropus guami Hartert, Nov. Zool., vol. 24, 1917, p. 268. (Guam.)

Guam Island: Achang Bay—1 male, 1 female, June 7, 18.

Ten specimens from Guam, Saipan, and Tinian in the collection of the United States National Museum have been compared with gallinules from other areas. These birds are similar to *G. c. indica* Blyth and to *G. c. lozanoi* Lletget but the upper wing-coverts are darker and near "olivaceous black," and the back, rump, and scapulars are also darker and less richly washed with olivaceous brown, though not as dark as representatives of *G. c. orientalis* Horsfield from Java. In size, the Mariana birds are similar to the former two races.

At Guam, gallinules were found in fresh-water marshes and in fallow rice paddies. Weights of the birds are: adult male 291, adult female 256. The male, collected June 7, had enlarged testes.

GALLINULA CHLOROPUS subsp.

Palau Islands: Angaur Island—1 unsexed adult, 2 juvenile males, September 21.

The single unsexed adult appears very distinct when compared with gallinules from adjacent areas. Its coloration is paler, the upper wing-coverts being less olivaceous brown and more slate colored, and the back, rump, and scapulars being less richly washed with olivaceous brown than specimens of *G. c. indica, G. c. lozanoi,* and *G. c. guami.* In size it resembles *G. c. orientalis* with wing 150 and tarsus 46, but it is also much paler than this race. The Handlist of Japanese Birds, 3d ed., 1942, p. 221, records *G. c. indica* from Babelthuap Island, Palau Islands.

The three birds were taken at fresh-water and brackish-water swamps on Angaur Island. Several birds were also observed at Peleliu Island (pl. 3, fig. 2). One of the juveniles was growing its wing feathers when collected, indicating that the birds must breed in the Palau Islands.

PORPHYRIO PORPHYRIO PELEWENSIS Hartlaub and Finsch

Porphyrio melanotus Temm. var. *Pelewensis* Hartlaub and Finsch, Proc. Zool. Soc. London, 1872, p. 107. (Pelew Islands.)

Palau Islands: Angaur Island—1 chick, September 21.

One chick was caught by Davison at the edge of a fresh-water lake at Angaur Island. An adult was flushed from the same area.

SQUATAROLA SQUATAROLA (Linnaeus)

Tringa Squatarola LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 149. (Europe, restricted type locality Sweden, *apud* Hartert.)

Guam Island: Achang Bay—1 female, August 27.

Markley collected one specimen of this migrant. It was the only black-bellied plover seen by our collecting parties in Micronesia.

PLUVIALIS DOMINICA FULVA (Gmelin)

Charadrius fulvus GMELIN, Syst. Nat., vol. 1, pt. 2, 1789, p. 687. (Tahiti.)

Guam Island: Pati Point—1 male, September 17; Facpi Point—1 female, September 26; Ylig Bay—2 males, 1 female, July 19, 24; Inarajan—1 male, 1 female, September 19; Agfayan Bay—2 males, July 8, 24; Achang Bay—6 males, 1 female, August 31, September 4, October 5, 8, 24. Machadgan Point (Umatac Bay)—1 female, October 23. Rota Island: Sosan Isthmus—1 male, 1 female, October 20, 26; Sabaanaa—2 males, 1 female, October 20. Ulithi Atoll: Bulubul Island—1 male, August 21; Pau Island—1 male, 1 female, August 21; Potangeras Island—1 male, August 16. Palau Islands (Peleliu Island): Akarakoro Point—5 males, 3 females, September 6, 8, 12, 16; Asias—1 female, September 13; Garakayo Island—1 female, September 20.

The golden plover was one of the most abundant migrants to pass through Micronesia during 1945. Birds were found on beaches, cleared areas, air strips, and short-grass uplands. At Guam, northbound birds were first seen on February 11. By April 1, plover in nuptial plumage were numerous. The last spring record was obtained on April 28. The first southbound birds were recorded on July 8, when three individuals were seen at Agfayan Bay. By September, plovers were again numerous. Birds in postnuptial molt were taken at Ulithi in August, at Palau in September, and at Guam as late as October 8. The five birds taken at Rota in late October were in winter plumage. McElroy saw birds at Truk in December.

Weights of seven males from Guam and Rota are 107-125 (117), of four females 109-120 (114). Stomach contents of birds examined at Ulithi and Peleliu included small shells and parts of crabs.

CHARADRIUS MONGOLUS MONGOLUS Pallas

Charadrius mongolus PALLAS, Reise Versch. Prov. Russ. Reichs, vol. 3, 1776, p. 700. (Salt lakes toward the Mongolian border = Kulussutai, probably on the Onon River, Siberia, *fide* Ridgway, 1919, p. 134.)

Guam Island: Agfayan Bay—1 male, June 7; Achang Bay—1 female, September 1. Ulithi Atoll: Losiep Island—1 female, August

22. Palau Islands (Peleliu Island): Akarakoro Point—2 males, 1 female, September 7, 8, 12.

Dotterels were observed on tidal flats. The stomach of a bird collected at Ulithi Atoll contained 1 cc. of marine worms.

CHARADRIUS LESCHENAULTII Lesson

Charadrius Leschenaultii Lesson, Dict. Sci. Nat., éd. Levrault, vol. 42, 1826, p. 36. (Pondichery, India.)

Palau Islands (Peleliu Island): Akarakoro Point—1 male, 6 females, September 6, 8, 12.

Small flocks of these shore birds were found on tidal flats at Peleliu in September.

NUMENIUS PHAEOPUS VARIEGATUS (Scopoli)

Tantalus variegatus Scopoli, Del. Flor. et Faun. Insubr., fasc. 2, 1786, p. 92. (No locality = Luzon, *ex* Sonnerat.)

Guam Island: Piti—3 females, July 26, 27; Ylig Bay—2 females, August 2; Inarajan—2 males, September 19; Agfayan Bay—2 males, 2 females, June 4, 6, July 24, August 27; Achang Bay—4 females, August 27, September 1, October 8; Umatac Bay—1 male, September 25. Ulithi Atoll: Potangeras Island—1 female, August 17. Palau Islands (Peleliu Island): Akarakoro Point—1 male, 3 females, September 8, 12; Asias—1 male, September 14; Angaur Island—2 males, 2 females, September 21.

Whimbrels were observed on beaches, cleared areas, and grassy uplands. At Guam, birds were seen in March on their northward migration, the last record being on March 21. The birds returned to Guam from the northern breeding grounds beginning in early summer, the first record being on June 1.

Weights of two adult males from Guam are 373-435 (404), and of six adult females 295-426 (384). The great variation in these weights may be due to the effects of migration.

NUMENIUS MADAGASCARIENSIS (Linnaeus)

Scolopax madagascariensis Linnaeus, Syst. Nat., ed. 12, vol. 1, 1766, p. 242. (Madagascar, error = Macassar, Celebes, as designated by Neumann.)

Curlews were observed on tidal flats at Guam on October 4 and at Ngesebus Island in the Palaus on September 20.

LIMOSA LAPPONICA BAUERI Naumann

Limosa Baueri NAUMANN, Naturg. Vög. Deutschl., vol. 8, 1836, p. 429. (New Holland = Victoria *apud* Mathews, Nov. Zool., vol. 18, 1912, p. 220.)

Palau Island (Peleliu Island): Akarakoro Point—1 male, September 7.

Godwits were seen in small numbers on tidal flats at Peleliu (pl. 4, fig. 1) in September and at Guam on April 26 and October 15.

TRINGA NEBULARIA (Gunnerus)

Scolopax nebularia GUNNERUS, *in* Leem. Beskr. Finm. Lapper, 1767, p. 251. (District of Trondhjem, Norway.)

Palau Islands (Peleliu Island): Akarakoro Point—2 females, September 14, 15; Mangrove swamp, 1¼ mi. SW. Akarakoro Point—1 male, 1 female, August 28.

At Peleliu the greenshank was observed on tidal flats and in mangrove swamps.

TRINGA GLAREOLA Linnaeus

Tringa Glareola LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 149. (Europe, restricted type locality, Sweden.)

Palau Islands: Angaur Island—1 male, September 21.

One specimen was collected at a fresh-water pond.

ACTITIS HYPOLEUCOS (Linnaeus)

Tringa Hypoleucos LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 149. (Europe, restricted type locality, Sweden.)

Guam Island: Achang Bay—2 males, 2 females, July 16, September 20. Ulithi Atoll: Losiep Island—1 female, August 22. Palau Islands (Peleliu Island): Asias—2 males, 1 female, September 9, 14.

Single birds were found on and along beaches. Stomachs of birds collected contained crab parts and insects. Weight of one male from Guam is 67, of two females 57 and 63.

HETEROSCELUS INCANUS BREVIPES (Vieillot)

Totanus brevipes VIEILLOT, Nouv. Dict. Hist. Nat., vol. 6, 1816, p. 410. (No locality given; the type is from Timor.)

Guam Island: Piti—1 male, July 27; Ylig Bay—2 females, July 24; Inarajan—1 male, September 19; Agfayan Bay—1 male, 1 female, June 4, 6; Achang Bay—2 males, 7 females, June 6, July 16, August 6, 27, September 4, October 5, 8; Bile Bay—1 female, October 23. Palau Islands (Peleliu Island): Akarakoro Point—2 males, 5 females, September 6, 7, 8, 16. Truk Islands: Moen Island—1 male, December 13.

Most of the birds taken in summer and fall, as late as October 23, were in postnuptial molt. Birds collected in June were in winter plumage (molting) and probably did not go to the breeding grounds. Weights of three males from Guam are 90-104 (95), of six females 99-116 (104).

HETEROSCELUS INCANUS INCANUS (Gmelin)

Scolopax incana GMELIN, Syst. Nat., vol. 1, pt. 2, 1789, p. 658. (Eimeo = [Moorea of the Society Group] and Palmerston Islands.)

Guam Island: Ritidian Point—1 female, May 29; Amantes Point—1 male, 1 female, May 26; Oca Point—1 male, 2 females, May 21, 24; Facpi Point—2 males, 1 female, September 19, 26, 27; Achang Bay—2 females, September 20, October 23; no locality—1 male, 1 female, October 10. Rota Island: Sosan Isthmus—2 unsexed, October 23, 25. Ulithi Atoll: Losiep Island—2 males, August 22; Mangejang Island—1 female, August 20.

At Guam, where both species of tattlers were found, *H. i. incanus,* in nuptial plumage, was collected in late May, the last record being on May 29. It was not seen again until August 20 at Ulithi and on September 19 at Guam. The birds taken as late as October 23 were in postnuptial molt. Southward-migrating *H. i. brevipes* was collected earlier, in July. No records for *H. i. incanus* were obtained in the Palaus.

Weights of two males from Guam are 175 (May) and 109 (September), and of two females in May, 175 and 192. The male collected in September was in poor physical condition, probably owing to the effects of migration.

ARENARIA INTERPRES (Linnaeus)

Tringa Interpres LINNAEUS, Syst. Nat., ed. 10, vol. 1, 1758, p. 148. (Europe and North America, restricted type locality, Gotland, Sweden.)

Guam Island: Facpi Point—2 males, 1 female, October 19, 26; Agfayan Bay—1 female, October 11; Achang Bay—1 male, October 20; Bile Bay—1 female, October 23; no locality—1 unsexed, October 10. Rota Island: Sosan Isthmus—2 males, October 20, November 2. Palau Islands (Peleliu Island): Akarakoro Point—1 male, September 8. Truk Islands: Moen Island—1 female, December 22.

Turnstones were found at Guam in late March. They were not seen again until July 24, when a group of three were observed at Agfayan

Bay. Weights of four males from Guam and Rota are 77-79 (92), of one female from Guam 90.

GALLINAGO MEGALA Swinhoe

Gallinago megala SWINHOE, Ibis, 1861, p. 343. (Between Takoo and Peking, China.)

Palau Islands: Angaur Island—1 female, September 21.

Several snipe were found in marshy areas at a small fresh-water lake on Angaur Island.

CROCETHIA ALBA (Pallas)

Trynga alba PALLAS, *in* Vroeg's Cat., 1764, Adumbr., p. 7. (Coast of the North Sea.)

Ulithi Atoll: Pau Island—1 male, August 21.

A small flock of sanderlings was seen on a beach at Ulithi.

CALIDRIS TENUIROSTRIS (Horsfield)

Totanus tenuirostris HORSFIELD, Trans. Linn. Soc. London, vol. 13, pt. 1, 1821, p. 192. (Java.)

Palau Islands (Peleliu Island): Akarakoro Point—4 males, September 16.

A flock of 20 of these birds was found at a tidal flat on Peleliu Island. Stomachs contained small shells. This is apparently the first record for this species in Micronesia.

CALIDRIS MINUTA RUFICOLLIS (Pallas)

Trynga ruficollis PALLAS, Reise Versch. Prov. Russ. Reichs, vol. 3, 1776, p. 700. ("Circa lacus salsos Dauriae campestris" = Kulussutai, southern Transbaikalia, *fide* Ridgway, 1919, p. 292.)

Rota Island: Sosan Isthmus—1 female, October 20. Palau Islands (Peleliu Island): Akarakoro Point—4 males, 10 females, September 6, 8, 12, 14; Angaur Island—1 female, September 21.

This species was numerous on the beaches at Peleliu Island. One female from Rota weighed 24.5.

CALIDRIS ACUMINATA (Horsfield)

Totanus acuminatus HORSFIELD, Trans. Linn. Soc. London, vol. 13, pt. 1, 1821, p. 192. (Java.)

Guam Island: Pati Point—1 female, September 17. Palau Islands: Angaur Island—2 males, 1 female, September 21.

CALIDRIS FERRUGINEA (Pontoppidan)

Tringa Ferrugineus Pontoppidan, Danske Atlas, vol. 1, 1763, p. 624. (No type locality = Denmark.)

Palau Islands (Peleliu Island): Akarakoro Point—1 female, September 6.

One specimen was collected at a tidal flat on Peleliu. This is apparently the first record for this species in Micronesia.

LIMICOLA FALCINELLUS SIBIRICA Dresser

Limicola sibirica Dresser, Proc. Zool. Soc. London, 1876, p. 674. (Siberia and China.)

Palau Islands: Angaur Island—1 male, September 21.

This bird was collected at a fresh-water pond. To my knowledge this is the first time that this species has been recorded in Micronesia.

CHLIDONIAS LEUCOPTERA (Temminck)

Sterna leucoptera Temminck, Man. d'Orn., 1815, p. 483. (Coasts of the Mediterranean.)

Palau Islands: Angaur Island—1 female, September 21.

One of four terns seen at a small fresh-water lake at Angaur Island was shot. The specimen is in winter plumage.

STERNA SUMATRANA SUMATRANA Raffles

Sterna Sumatrana Raffles, Trans. Linn. Soc. London, vol. 13, pt. 2, 1822, p. 329. (Sumatra.)

Ulithi Atoll: Losiep Island—1 male, August 22; Mangejang Island—1 male, 1 female, 1 juvenile male, August 20; Potangeras Island—2 females, 1 juvenile female, August 15, 16.

Terns were found in small numbers at Ulithi Atoll. A single bird was seen at Peleliu Island on September 16. Stomachs of the birds collected contained small fish. Some of the specimens were in molt. The two terns collected at Okinawa have slightly longer wings than those of the Micronesian birds.

THALASSEUS BERGII CRISTATUS (Stephens)

Sterna cristata Stephens, in Shaw's Gen. Zool., vol. 13, pt. 1, 1826, p. 146. (China and many of the southeastern islands of Asia; restricted type locality, China.)

Ulithi Atoll: Bulubul Island—1 male, August 21.

One of four crested terns seen at Bulubul Island was collected. The birds were wary and difficult to approach. Stomach contents of the bird obtained included 2 cc. of fish. Terns were also seen at Peleliu and Ngajangel in the Palau Islands in September and at Truk Islands in November.

ANOÜS STOLIDUS PILEATUS (Scopoli)

Sterna pileata SCOPOLI, Del. Flor. et Faun. Insubr., fasc. 2, 1786, p. 92. (No locality = Philippines, *ex* Sonnerat.)

Guam Island: Amantes Point—1 male, 2 females, July 21; Ypao Point—2 males, 1 juvenile male, June 29, July 6; Oca Point—1 male, 1 female, May 21, 24. Rota Island: Taipingot Peninsula—1 male, 1 female, October 24; Sosan Isthmus—1 female, October 18. Ulithi Atoll: Bulubul Island—1 juvenile male, August 21; Potangeras Island—4 males, August 15. Palau Islands (Peleliu Island): Southeastern Peninsula—1 male, 1 female, September 1; Ngabad Island—1 male, September 11.

This noddy was one of the most frequently observed oceanic birds in Micronesia. At Ulithi Atoll service personnel reported a large nesting colony in May, June, and July at Potangeras and at a smaller island nearby. Nests were observed in trees and on the ground. One nest was found by our party at Bulubul Island on August 21. A single egg, in an advanced stage of incubation, was collected from the nest, which consisted of a few rough twigs in a shallow depression in the sand above the high-tide mark. The egg is: shape ovate, gloss slight, shell smooth, color white with small irregular spots of the two colors "pale drab-gray" and "pale smoke gray" (the latter predominating), concentrated at the large end, size 36.6 by 50.1. At Truk, McElroy found noddy terns nesting on a high cliff and in adjacent coconut trees at Moen Island in December.

Weights of birds taken at Guam and Rota are: 4 adult males 187-204 (197), and 3 adult females 177-203 (189). Measurements of 10 adult males are: wing 275-291 (283), tail 159-187 (168), exposed culmen 39.8-43.5 (41.4); of 4 adult females, 266-283 (274), 154-178 (165), 38.7-40.0 (39.3). Stomachs of birds from Ulithi and Palau contained small fish and crustaceans. Two males from Palau had enlarged testes.

ANOÜS TENUIROSTRIS MARCUSI (Bryan)

Micranous marcusi BRYAN, Occ. Pap. B. P. Bishop Mus., vol. 2, 1903, p. 101. (Marcus Island.)

Ulithi Atoll: Mangejang Island—2 males, 2 females, August 20. Palau Islands (Peleliu Island): Akarakoro Point—1 juvenile male, September 12; Eastern Peninsula—1 female, September 9.

White-capped noddy terns were found at Ulithi, Palau, and Truk. They were not seen in the Marianas. Stomachs of birds collected contained small fish. Measurements of 2 adult males are: wing 222 and 228, tail 117 and 124, exposed culmen 46.1 and 46.6; of 3 adult females, 228-229 (228), 118-120 (119), 41.1-43.6 (42.6).

GYGIS ALBA subspp.

Guam Island: Ritidian Point—1 male, 1 female, May 29; Mount Santa Rosa—1 female, June 23; Tumon Bay—1 male, 1 female, June 8; Pagat Point—1 female, July 10; Oca Point—1 female, May 23; Agaña Swamp—1 male, 1 female, June 15; Ylig Bay—1 male, August 27; Talofofo Bay—5 males, June 14; Agfayan Bay—1 male, June 6; Port Ajayan—1 female, June 18. Rota Island: Sosan Isthmus—2 males, October 19, 25. Ulithi Atoll: Bulubul Island—1 nestling, August 21; Mangejang Island—1 male, August 20; Potangeras Island—7 males, 3 females, August 14, 15, 16. Palau Islands (Peleliu Island): Southeastern Peninsula—1 juvenile male, September 1. Truk Islands: Moen Island—1 juvenile male, December 13.

White terns collected in Micronesia have been compared with specimens from the Mariana Islands, the Hawaiian Islands, and Wake Island at the United States National Museum through the courtesy of Dr. Alexander Wetmore and with 17 birds from the Caroline Islands at the American Museum of Natural History through the courtesy of Dr. Robert Cushman Murphy. The measurements of these birds are as follows:

Males	Wing	Exposed culmen
14 adults (Hawaiians)	226-246 (235)	35-39 (37)
4 adults (Wake)	232-242 (236)	37-39 (38)
14 adults (Marianas)	227-242 (238)	37-40 (39)
15 adults (Carolines)	237-252 (246)	37-44 (42)

Females	Wing	Exposed culmen
13 adults (Hawaiians)	217-243 (232)	33-39 (36)
6 adults (Wake)	230-243 (236)	36-41 (38)
9 adults (Marianas)	228-240 (234)	36-40 (38)
11 adults (Carolines)	234-248 (242)	37-43 (41)

The latest treatment of *Gygis alba* (Peters, Checklist Birds of the World, vol. 2, 1934, p. 348-349) refers the Hawaiian birds to *G. a. rothschildi* Hartert and the Central Pacific birds to *G. a. candida* (Gmelin)—except birds from the Marquesas Islands, *G. a. microrhyncha* Saunders. The Japanese checklist for 1942 (p. 219) places the birds from Wake Island in *G. a. candida*. On the basis of the material studied, birds from the Hawaiian group (Laysan, Gardiner, Necker, Nihoa, French Frigate, Johnson Islands) have the smallest measurements, with those to the south having progressively larger measurements, with the exception of the Marquesas form. Hartert (Nov. Zool., vol. 34, 1927, p. 18) finds that in *G. a. rothschildi* the exposed culmen does not exceed 38 mm. and the wing does not exceed 245 mm. My findings agree with these; however, measurements of birds from Wake, Guam, Rota, and Saipan are almost identical with those of the Hawaiian birds with the maxima and minima very similar. Birds from the Caroline Islands (Ulithi, Truk, and Kusaie), as shown in the table, average larger in size, and there is no great amount of overlap in wing length. Whether or not the Caroline Islands birds are distinct, as supposed by Hartert when he named *G. a. kittlitzi,* can only be learned when a large series of birds from more southern localities are studied. The presence of the distinct race in the Marquesas Islands offers further evidence that other separable forms may be present. It seems apparent from this study that the Hawaiian race, *G. a. rothschildi,* is not sufficiently distinct to be separated by name from populations at Wake and in the Marianas.

At Guam, white terns were numerous and distributed in all parts of the island, especially in the coconut groves. Birds were found breeding during the spring months. A downy young first observed in a banyan tree on March 27 began to fly on April 17. Most of the birds collected in May, June, and July were in molt. One of the two birds collected at Rota in October was in molt. Weights of nine adult males from Guam are 97-119 (108), of six adult females 100-116 (108). Weights of two adult males from Rota are 115 and 124.

At Ulithi Atoll, terns were abundant. There was apparently a peak in nesting activity in April, May, and June, service personnel reporting a number of very young birds at that time. The eggs were placed in limb forks of breadfruit trees. One recently hatched downy young was collected at Bulubul Island on August 21. Six of eleven adults taken at Ulithi in August were in molt. At Truk and the Palau Islands, white terns were numerous in coconut groves. Stomachs of birds taken at Ulithi and Peleliu contained fish, insects, and marine crustaceans.

The back of a juvenile male (collected September 1) from Peleliu Island is barred with bands of near "mummy brown" and light buff. The coloring extends to the scapulars, innermost secondaries, and upper wing-coverts and to the crown and occiput, where the coloring is more mottled than barred. The feathers of the sides of the neck have some brownish edges. An adult female, taken at Guam on May 23 and examined within 1 hour after death, had feet colored "Russian blue," webs white, basal part of bill to nares "soft blue-violet," terminal part of bill black, iris black, feathers white, and skin black. These color notes were made by David H. Johnson.

PTILINOPUS ROSEICAPILLUS (Lesson)

Columba roseicapilla Lesson, Traité d'Orn., livr. 6, 1831, p. 472. (îles Mariannes.)

Guam Island: Ritidian Point—1 male, August 1; Tarague—1 male, 1 female, July 18; Haputo Point—1 male, August 21; Mount Santa Rosa—1 male, July 2; Pagat Point—6 males, 1 female, 1 nestling, July 6, 10; Amantes Point—4 males, May 25, 27; Oca Point—2 females, March 8; Agaña Swamp—1 male, 1 female, June 3; Ylig Bay—1 male, 1 female, July 19; Agat—1 male, June 12; Talofofo Bay—1 male, June 14. Rota Island: Sosan Isthmus—1 male, November 2; Poniya Point—1 male, October 28; Sabaanaa—1 male, October 31.

The similarity between this species and birds of the *Ptilinopus regina* group of the Australian area is striking. This has been indicated by Ripley and Birckhead (Amer. Mus. Novit., No. 1192, 1942, p. 3). On the basis of its characters alone the Mariana birds would merit only subspecific separation, but owing to the great distance between the two doves and the possibility of independent origin and subsequent convergence, it may be more advisable to continue to regard the two as separate species.

Fruit doves were found in most forested areas. At Guam, the construction of installations and air strips removed some of the habitat of this bird, but the population has not been greatly affected. Weights of 14 adult males are 81-103 (90), of 4 adult females 85-99 (92), and of one nestling in postnatal molt, beginning to fly, 44. Breeding birds were taken in March and July. The birds from Rota have slightly richer coloration on the crown and back than have birds from Guam.

PTILINOPUS PORPHYRACEUS PONAPENSIS (Finsch)

Ptilonopus ponapensis Finsch, Proc. Zool. Soc. London, 1877 (1878), p. 779. (Ponape, Caroline Islands.)

Truk Islands: Moen Island—1 male, December 24.

McElroy collected one breeding male at Moen Island. He found the birds at high elevations in deep woods.

PTILINOPUS PORPHYRACEUS PELEWENSIS Hartlaub and Finsch

Ptilinopus pelewensis HARTLAUB AND FINSCH, Proc. Zool. Soc. London, 1868, p. 7. (Pelew Islands.)

Palau Islands (Peleliu Island): Eastern Peninsula—1 male, August 27; Southeastern Peninsula—2 males, September 1, 4; Ngabad Island—2 males, September 11; Garakayo Island—1 male, September 19.

The Palau fruit dove was found in thick forested areas on all the islands visited. A nest was observed in a jungle area at Ngabad Island on September 11. The nest was loosely constructed, about 6 feet from the ground in a low tree. The one incubated egg was white and measured 31 by 23. Three males collected had enlarged testes. Stomachs contained berries and seeds.

DUCULA OCEANICA MONACHA (Momiyama)

Globicera oceanica monacha MOMIYAMA, Birds of Micronesia, March 1922, p. 4. (Yap, Western Caroline Islands.)

Palau Islands (Peleliu Island): Asias—1 female, August 27; Eastern Peninsula—1 male, August 28; Southeastern Peninsula—4 males, 1 female, August 29, September 4, 5; Garakayo Island—1 male, September 19.

The large pigeon was found in forests and on faces of cliffs where the war activities had not created much disturbance. British Indian troops released by the Japanese in September reported extensive use of this pigeon as food by the people on Babelthuap Island. Stomachs of birds collected contained berries, fruit parts, and green matter.

McElroy did not find any birds of this species at Truk.

STREPTOPELIA BITORQUATA DUSUMIERI (Temminck)

Columba dusumieri TEMMINCK, Pl. Col., livr. 32, 1823, pl. 188. (Vicinity of Manila, Luzon, Philippine Islands.)

Guam Island: Tarague—2 males, July 18; Pagat Point—4 males, July 6, 10; Amantes Point—1 male, 3 females, May 25, 26; Tumon Bay—1 female, June 9; Oca Point—1 female, February 7; Agaña Swamp—1 male, October 8; Piti—1 male, September 8; Pago River—2 males, 1 female, July 23, August 11; Ylig Bay—1 female, August 2; Agfayan Bay—2 females, July 7; no locality—1 female, September. Rota Island: Sosan Isthmus—2 males, October 18, November 2; Taruka—1 male, October 23; Poniya Point—1 female, October 22.

The introduced turtle dove was abundant on Guam and Rota. It appeared to prefer the open country and favored some of the clearings made by war activities. A nest found at Mount Santa Rosa, Guam, in a low bush on June 28 contained one egg and a nestling. Two eggs collected by Necker at Rota on October 31 are white and measure 29.6 by 23.0 and 30.1 by 23.0. Weights of five adult males are 130-167 (152), and of six adult females 135-159 (146). There are only very slight differences between the birds of the Marianas and those from the Philippines, from where the introduced stock originally came.

GALLICOLUMBA XANTHONURA XANTHONURA (Temminck)

Columba xanthonura "Cuv." TEMMINCK, Pl. Col., livr. 32, 1823, pl. 190. (Marianne Islands.)

Guam Island: Ritidian Point—1 male, 1 female, 1 juvenile female, June 28; Mount Santa Rosa—1 male, 2 females, June 23, 24, July 2; Haputo Point—1 male, 1 juvenile female, August 21; Pagat Point—2 males, 2 females, July 6, 10; Sassayan Point—1 male, July 6; Amantes Point—1 male, May 28; Tumon Bay—2 females, June 9, 27; Oca Point—2 males, 1 juvenile female, March 18, April 4, 17; Agaña Swamp—1 male, June 2; Sinajana—1 male, May 20; Piti—1 male, June 28; Pago River—2 males, July 23, August 11; Talofofo Bay—1 male, June 14. Rota Island: Sosan Isthmus—3 males, October 20, 26, November 1; Sabaanaa—1 male, November 2; Mariiru Point—1 female, October 22; Poniya Point—1 male, October 25.

The white-throated ground dove was not observed on the ground. It was found in forested areas, and being a strong flyer, was often seen flying high above the trees and across roads. At Guam, birds nested in the winter and spring months, beginning in late January. Nests were found in breadfruit and banyan trees 50 to 75 feet above the ground. A broken egg was found beneath a tree containing a nest on February 26. A male bird was seen on a nest at Oca Point on March 27 in the middle of the day. On April 3 the young bird from this nest at Oca Point was beginning to fly. Adults with enlarged gonads were taken in April, May, June, and July. Weights of seven adult males are 119-154 (130), of seven adult females 96-150 (118).

A bird, marked female and collected at Guam on July 2, has a light drab breast tinged with light brown and darkening toward the throat. The crown resembles that of an adult female though darker and becoming lighter and grayer on the neck and nape. The coloring of the shoulder and wing-coverts compares favorably with that of the adult male though lighter and with a yellowish tinge. The back is bronzed olive green as in the female but with a few of the purplish feathers characteristic of the male present on the mantle. The abdomen is near "olive brown" with buffy-brown edges to the feathers. This specimen resembles somewhat the description of a juvenile male from Yap by Hartlaub and Finsch (Proc. Zool. Soc. London, 1872, p. 102), but it is unmistakably a female since it was noted to be unusual at the time and special attention was given to the accurate sexing of the bird. The presence of a second plumage for females of this race is not surprising since Amadon (Amer. Mus. Novit., No. 1237, 1943, p. 20) has described a male type plumage for females of *Gallicolumba stairi* from Polynesia.

GALLICOLUMBA XANTHONURA KUBARYI (Finsch)

Phlegoenas Kubaryi Finsch, Journ. Orn., vol. 28, 1880, p. 292. (Ruck and Ponape, Caroline Islands.)

McElroy saw six of these birds at Moen Island. All were observed on forested slopes in tall trees. He reports that their habits are very similar to those of the birds in the Marianas.

GALLICOLUMBA CANIFRONS (Hartlaub and Finsch)

Phlegoenas canifrons Hartlaub and Finsch, Proc. Zool. Soc. London, 1872, p. 101. (Palau Islands.)

Palau Islands (Peleliu Island): Southeastern Peninsula—1 male, 1 juvenile female, August 29, September 1; Garakayo Island—2 males, September 17, 19.

This secretive, terrestrial dove was found in jungle areas. Its call, a low moan, announced its presence, although the bird was difficult to see against the ground cover of its environment. It would fly only a few yards when disturbed. Its habits were strikingly different from those of *Gallicolumba xanthonura,* which our field parties observed at Guam, Rota, and Truk.

The female collected September 1 was in postjuvenal molt. Stomachs contained hard seeds.

CALOENAS NICOBARICA PELEWENSIS Finsch

Caloenas nicobarica var. *pelewensis* Finsch, Journ. Mus. Godeffr., vol. 8, 1875, p. 159 (p. 27 in reprint). (Palau Islands.)

The Nicobar pigeon was observed on five occasions at Garakayo Island in the Palaus. It apparently preferred the vegetation along high coral cliffs, where it was found perched on the outer limbs of the shrubby trees.

COLLOCALIA INEXPECTATA PELEWENSIS Mayr

Collocalia pelewensis Mayr, Amer. Mus. Novit., No. 820, 1935, p. 3. (Palau Islands.)

Palau Islands (Peleliu Island): Asias—1 male, September 13; Garakayo Island—1 male, 1 female, September 18.

Swiftlets were numerous and were found at all islands visited in the southern Palaus.

COLLOCALIA INEXPECTATA BARTSCHI Mearns

Collocalia bartschi Mearns, Proc. U. S. Nat. Mus., vol. 36, 1909, p. 476. (Guam.)

Guam Island: Amantes Point—7 males, 3 females, June 21, July 29; Oca Point—1 female, January 29; Sinajana—1 female, 2 unsexed, 6 nestlings, May 20. Rota Island: 1 unsexed, October 27.

At Guam and Rota, swiftlets were found at cliff areas, where they nested in caves. In jungle areas they were seen flying above the trees and through the more open woodland. On May 18 a large colony of birds was nesting in a rocky sink hole about 2 miles east of Agaña, Guam. About 250 nests were found on ledges in the caverns sheltered from the light. Below the nests were large piles of guano. Weights of seven adult males 6.4-7.3 (6.8), of three adult females 6.8-7.6 (7.1).

HALCYON CINNAMOMINA PELEWENSIS Wiglesworth

Halcyon pelewensis Wiglesworth, Abhandl. und Ber. Zool. Mus. Dresden, 1890-91 (1891), No. 6, p. 15. (Pelew Islands.)

Palau Islands (Peleliu Island): Small island off Eastern Peninsula—1 male, September 10; Ngabad Island—1 juvenile male, 1 female, 1 juvenile female, September 11.

This kingfisher was observed in thick jungle areas and at the edge of mangrove swamps on small islands near Peleliu. The birds were very secretive, only six individuals being seen by our collecting party. These were located by their distinctive rasping call. Stomachs contained insects.

McElroy saw a kingfisher with cinnamon underparts at Bulubul Island, Ulithi Atoll, on August 21. The bird disappeared into thick vegetation when approached.

HALCYON CINNAMOMINA CINNAMOMINA Swainson

Halcyon cinnamomina Swainson, Zool. Illustr., vol. 2, 1821-22 (1821), text to pl. 67. (No locality = Mariana Islands.)

Guam Island: Ritidian Point—1 female, 1 juvenile female, June 28, 29; Tarague—1 female, July 18; Yigo—1 male, 2 females, May

25, 26; Dededo—1 male, June 16; Pagat Point—3 males, 2 females, 1 juvenile male, July 6, 10; Amantes Point—1 male, 1 female, May 25, June 11; Oca Point—3 males, 1 female, 1 juvenile male, 1 juvenile female, February 14, 24, March 8, August 24, 30; Agaña Swamp—1 male, 2 females, June 2, 3, 4; Agat—1 male, June 13; Talofofo Bay—2 males, 1 female, June 14; Agfayan Bay—1 male, 1 female, June 6, July 7; Port Ajayan—2 females, 1 juvenile male, June 19; Achang Bay—2 males, June 18.

There is some color variation in the large series of birds examined. A number of specimens have light-colored crowns, but this may be fading as mentioned by Hartert (Nov. Zool., vol. 5, 1898, p. 52). The feathers of the head are worn in some individuals, possibly from rubbing when the birds entered and left nest holes.

Nests were observed in hollows in trees in the period from March to July. Holes in banyan and coconut trees often 20 feet or more above the ground were used. At Oca Point, on April 3, parent birds were observed feeding a nestling. On July 8 a nest containing two eggs was found. Birds in juvenal plumage were taken in May, June, July, and August. Some of the adults taken in February, May, June, and July were in molt. Weights of 11 adult males are 56-62 (59), of 10 adult females 58-76 (66).

HALCYON CHLORIS ORII Takatsukasa and Yamashina

Halcyon chloris orii Takatsukasa and Yamashina, Dobutsu. Zasshi, vol. 43, 1931, p. 484. (Rota Island, Mariana Islands.)

Rota Island: Sosan Isthmus—2 males, 3 females, 1 juvenile male, 1 juvenile female, October 18, 19, November 2; Poniya Point—1 female, 1 juvenile female, October 22; Taruka—1 juvenile male, 1 unsexed, October 26.

This kingfisher was observed in all parts of Rota. Weights of two adults are 84 and 85.

HALCYON CHLORIS TERAOKAI Kuroda

Halcyon chloris teraokai Kuroda, Tori, vol. 1, 1915, p. 56. (Pelew Islands.)

Palau Islands (Peleliu Island): Akarakoro Point—1 female, September 6; Eastern Peninsula—1 juvenile female, August 27; Southeastern Peninsula—3 males, 7 females, 1 juvenile female, August 29, 30, 31, September 1, 5; Garakayo Island—2 males, 1 female, September 20.

This kingfisher was a conspicuous bird at all the islands visited in the southern Palaus. It preferred open woodland and cleared areas to the thicker jungle. Its range appeared separate and distinct from that of the more restricted and secretive species, *Halcyon cinnamomina pelewensis*. Two of the birds collected were in molt. One female had enlarged gonads. Stomachs contained insects, fish, crabs, and shrimp.

HIRUNDO RUSTICA GUTTURALIS Scopoli

Hirundo gutturalis Scopoli, Del. Flor. et Faun. Insubr., fasc. 2, 1786, p. 96. (Panay, Philippine Islands, *ex* Sonnerat.)

Palau Islands: Angaur Island—1 male, September 21.

A few swallows were observed along beaches and inland lakes at Angaur and Ngesebus Islands. At Guam, four birds were seen flying over Agaña River on October 11. The stomach of the male collected at Angaur Island contained about 2 cc. of flies, beetles, and small grasshoppers.

EDOLISOMA TENUIROSTRE MONACHA (Hartlaub and Finsch)

Campephaga monacha Hartlaub and Finsch, Proc. Zool. Soc. London, 1872, p. 99. (Pelew Islands.)

Palau Islands (Peleliu Island): Southeastern Peninsula—2 females, August 29, 30.

This bird appeared to be rare in the jungle areas of Peleliu Island. Only the two individuals collected were seen. Stomachs contained insects and plant parts.

DICRURUS MACROCERCUS HARTERTI Stuart Baker

Dicrurus ater harterti Stuart Baker, Nov. Zool., vol. 25, 1918, p. 299. (Formosa.)

Rota Island: Sosan Isthmus—1 female, 4 juvenile males, 2 juvenile females, October 18, 19, November 2.

This drongo was apparently introduced from Formosa by the Japanese South Seas Development Company (Nanyo Kohatsu Kabushiki Kaisha) about 1935. An illustrated booklet, printed by this organization and seen by members of our collecting party at the Rota Military Government headquarters, showed pictures of the captive birds before release and indicated that they had been brought for the purpose of controlling destructive insects. Dr. Charles Vaurie has examined these birds and compared them with a series of drongos from Formosa in the collection of the American Museum of Natural History.

The drongo appeared well adapted at Rota, where it preferred cultivated areas and the bombed village sites to thick woodlands. Birds were found in small flocks often in the large shade trees. Weights of two juvenile males are 53 and 61.

CORVUS KUBARYI Reichenow

Corvus kubaryi Reichenow, Journ. Ornith., 1885, p. 110. (Pelew Islands, error = Guam.)

Guam Island: Ritidian Point—2 males, 4 females, 1 juvenile male, May 29, June 4, 28, 29, August 1; Tarague—1 male, 1 female, 2 juvenile females, July 12, 18; Pati Point—1 male, 1 juvenile male, 1 juvenile female, September 11; Pagat Point—1 male, 2 females, July 10; Yigo—1 female, May 25; Tumon Bay—1 juvenile male, 2 juvenile females, June 8, 9; Talofofo Bay—1 male, 1 juvenile male, September 5; Agfayan Bay—1 juvenile male, July 7; Port Ajayan—1 female, 1 unsexed juvenile, June 18. Rota Island: Sosan Isthmus—1 male, October 25; Poniya Point—1 male, 1 juvenile female, October 22, 25; Siebu Village—1 male, October 29.

Crows from Guam and Rota are very similar. Their measurements are within the range of those listed by Meinertzhagen (Nov. Zool., vol. 33, 1926, p. 75). The birds were found in jungle areas, coconut groves, and along the military roads. No evidence of breeding was found in specimens collected in the summer and early fall, and it is likely that nesting activities may be concentrated in the winter and spring months. One nest in a banyan tree was found at Ypao Point on March 8. Specimens taken from May to September were in molt. Weights of crows from Guam are: 2 adult males 237 and 270, 8 adult females 205-260 (246); from Rota: 1 adult male 256.

An adult bird taken at Pagat Point on July 10 has a freak development of the bill. The mandible and maxilla do not fit together but have grown out from each other as long projections. The bird seemed to be in good physical condition when collected and weighed 237 grams, but it must have had considerable difficulty obtaining food.

PSAMATHIA ANNAE Hartlaub and Finsch

Psamathia annae Hartlaub and Finsch, Proc. Zool. Soc. London, 1868, p. 5, pl. 2. (Pelew Islands.)

Palau Islands (Peleliu Island): Southeastern Peninsula—1 male, 2 females, August 29, 30, September 4; Ngabad Island—1 female, September 11.

Warblers were found in jungle areas and in the new vegetation which was covering the battle-torn parts of Peleliu. This species occurred in the same environment as the large white-eye, *Rukia palauensis,* and the similarity between these two forms in the field is striking. Stomachs contained insects.

ACROCEPHALUS LUSCINIA LUSCINIA (Quoy and Gaimard)

Thryothorus luscinius QUOY AND GAIMARD, Voy. *Astrolabe,* Zool., vol. 1, 1830, p. 202, pl. 5, fig. 2. (Guam.)

Guam Island: Agaña Spring—2 males, 1 female, June 2; Piti—1 male, June 13; Agat—1 male, August 30.

At Guam, reed warblers were found in association with the extensive cane growths in fresh-water and brackish-water marshes. Birds appeared fairly numerous in some of these areas; their songs could be heard, but it was difficult to approach them. The birds seemed shy and hopped about in the cane usually close to the ground. Fire appears to be a hazard to the reed warbler. During very dry periods, its habitat might be easily destroyed by fire.

Weights of three adult males from Guam are 29-35 (33), and of one adult female 27. This bird was not found at Rota by our collecting party.

ACROCEPHALUS LUSCINIA SYRINX (Kittlitz)

Sylvia Syrinx KITTLITZ, Mém. Acad. Imp. Sci. St. Petersbourg, vol. 2, 1835, p. 6, pl. 8. (Lugunor and "Ulcei," Caroline Islands.)

McElroy found reed warblers in cane swamps at Moen, Udot, and Dublon islands in the Truk Atoll. He saw birds carrying nest materials. Two adults examined in December had enlarged gonads. Specimens were lost in shipment.

RHIPIDURA RUFIFRONS URANIAE Oustalet

Rhipidura uraniae OUSTALET, Bull. Soc. Philom. Paris, ser. 7, vol. 5, 1881, p. 76. (Marianne group.)

Guam Island: Ritidian Point—3 males, 2 females, 1 unsexed, May 29, 30; Tarague—1 male, July 12; Talofofo Bay—2 males, 1 female, June 14; Agfayan Bay—1 male, 1 unsexed juvenile, June 6; Port Ajayan—2 males, June 18.

Fantails were found in forested areas where there was a thick undercover of vines and shrubs. Birds collected in May and June were in molt. Weights of nine males are 8.0-10.0 (9.0), of three females 7.3-9.6 (8.8).

RHIPIDURA RUFIFRONS MARIAE R. H. Baker

Rhipidura rufifrons mariae R. H. Baker, Proc. Biol. Soc. Washington, vol. 59, 1946, p. 77. (Rota Island, Mariana Islands.)

Rota Island: Mariiru Point—2 males, October 22.

The naval field party reported that this bird was numerous in the forested areas at Rota. Weights of two males are 8.5 and 9.0.

RHIPIDURA LEPIDA Hartlaub and Finsch

Rhipidura lepida Hartlaub and Finsch, Proc. Zool. Soc. London, 1868, p. 6. (Pelew Islands.)

Palau Islands (Peleliu Island): Southeastern Peninsula—2 males, 1 female, 1 juvenile male, August 29, 30, 31.

At Peleliu, fantails were found in the forested regions and in the new vegetation covering battle areas. One male had enlarged testes.

MYIAGRA FREYCINETI Oustalet

Myiagra Freycineti Oustalet, Bull. Soc. Philom. Paris, ser. 7, vol. 5, 1881, p. 73. (Marianne Islands = Guam Island.)

Guam Island: Ritidian Point—1 male, 1 juvenile male, May 29, 30; Tarague—1 male, 1 juvenile male, July 12; Pati Point—1 female, June 4; Mount Santa Rosa—2 males, 1 female, 1 nestling, May 21, June 24; Oca Point—2 females, January 21, March 16; Agaña Swamp—1 male, 1 unsexed, June 3, 4; Pagat Point—1 unsexed, July 10; Pago River—1 female, 2 juvenile males, July 23; Piti—1 juvenile male, June 13; Agat—1 male, August 30; Talofofo Bay—2 males, 1 unsexed, June 14.

There appears to be considerable variation in the amount of cinnamon coloring on the breast of adults. This character varies from nearly white on some individuals to dark cinnamon on others. The birds were found in brushy areas on Guam. An egg found in a nest in a bamboo clump near Mount Santa Rosa on May 7 hatched on May 20 (pl. 4, fig. 2). The nest was about 6 feet from the ground. Molting birds were taken in January, May, June, and July. Weights of five adult males are 10.5-12.5 (11.9), of two adult females 11.4 and 12.0.

MYIAGRA OCEANICA Pucheran

Myiagra oceanica Pucheran, Voy. Pôle Sud, Zool., vol. 3, 1853, p. 77. (Hogoleu = Truk.)

Two adults with enlarged gonads were examined in December by McElroy at Moen Island.

MYIAGRA ERYTHROPS Hartlaub and Finsch

Myiagra erythrops Hartlaub and Finsch, Proc. Zool. Soc. London, 1868, p. 6. (Pelew Islands.)

Palau Islands (Peleliu Island): Southeastern Peninsula—1 juvenile male, 1 female, August 30; Ngabad Island—1 male, 1 juvenile male, September 11; Garakayo Island—1 male, September 18.

The Palau broadbill was not abundant in the southern Palaus in 1945. It was observed most frequently on the smaller islands, Ngabad and Garakayo. It prefers the dense undergrowth of the jungles and second-growth scrub, where it is a much less conspicuous bird than the Palau fantail, *Rhipidura lepida*.

Stomachs contained fragments of insects.

COLLURICINCLA TENEBROSA (Hartlaub and Finsch)

Rectes tenebrosa Hartlaub and Finsch, Proc. Zool. Soc. London, 1868, p. 6. (Pelew Islands.)

Palau Islands (Peleliu Island): Eastern Peninsula—1 male, September 6; Southeastern Peninsula—3 males, 1 female, August 29, 30; September 1; Ngabad Island—1 male, 1 female, September 11; Garakayo Island—2 females, 1 juvenile male, September 18.

This bird was found in woodland areas at all the islands visited in the southern Palaus. It appeared to prefer heavy undergrowth and was found in the scrub vegetation covering the battle areas (pl. 5, fig. 1). Many of the specimens collected were in molt. Stomachs contained seeds, plant parts, and insects.

APLONIS OPACUS GUAMI Momiyama

Aplonis opaca guami Momiyama, Birds of Micronesia, 1922, p. 9. (Guam.)

Guam Island: Ritidian Point—3 males, 2 females, 1 juvenile female, May 29; Amantes Point—4 males, 2 females, 1 juvenile male, 2 juvenile females, May 25, 27; Dededo—1 female, June 16; Oca Point—4 females, 5 juvenile females, January 21, 22, February 5, March 8, 13, April 12, June 3, July 14, August 24; Pagat Point—1 female, July 6; Agaña Swamp—2 juvenile males, June 4, October 8; Sinajana—1 juvenile male, 1 unsexed, May 18, 22; Talofofo Bay—1 male, June 14; Agfayan Bay—1 female, 1 juvenile female, 1 unsexed, June 6, July 7; Port Ajayan—1 female, June 18; Achang Bay—1 juvenile female, June 6. Rota Island: Sosan Isthmus—4 males, 5 juvenile males, 1 juvenile female, October 18, 19, 26, 27, November 2; no locality—1 juvenile male, 1 unsexed juvenile, October 27.

There are only slight differences among the measurements of starlings from Guam and Rota and from Saipan and Tinian. The following measurements include those of specimens from the collections of the United States National Museum and the American Museum of Natural History. The birds from Saipan and Tinian have a slightly longer wing and a slightly thicker bill than birds from Guam and Rota.

	Wing	Tail	Full culmen	Depth of bill
21 adult males (Guam)	122-130 (127)	81-91 (87)	25-29 (27.5)	8.5- 9.5 (9.0)
4 adult males (Rota)	120-122 (122)	88-89 (89)	26-28 (27)	8.5- 9.0 (9.0)
12 adult males (Tinian)	126-136 (131)	81-90 (86)	24-29 (27)	9.0-10 (9.5)
4 adult males (Saipan)	130-131 (131)	81-87 (85)	26-28 (27)	10-10.5 (10)
24 adult females (Guam)	117-123 (120)	79-88 (84)	25-30 (26)	8.5- 9.5 (9.0)
7 adult females (Tinian)	123-126 (125)	82-89 (84)	24-27 (25)	9.5-10 (10)

On Guam and Rota, this starling was one of the most abundant birds observed. It was found in both jungle and open country. There was evidence of nesting at Guam during the spring and summer. Nests were found in tree hollows and in cliff holes. On June 2 a nest was examined in a cavity of a banyan tree about 12 feet from the ground. It was made of green leaves and twigs and contained two eggs, partly incubated. The eggs are pale "Niagara green" with scattered, irregular spots of color, near "russet," "Mars brown," and "pallid purple-drab," most abundant near the large ends. Measurements are 32.1 by 22.1, and 32.0 by 22.4.

Adult birds in molt were collected in most of the months from February to November at Guam. Weights of Guam birds are: 6 adult males 84-96 (87), 8 adult females 78-108 (86), 2 juvenile males 88 and 90, and 5 juvenile females 77-87 (80). Weights of Rota specimens are: 2 adult males 70 and 83, and 5 juvenile males 64-80 (76).

APLONIS OPACUS ANGUS Momiyama

Aplonis opaca anga Momiyama, Birds of Micronesia, 1922, p. 6. (Toroas, Ruk Island, Middle Carolines.)

Truk Islands: Moen Island—1 juvenile male, December 13. Ulithi Atoll: Pau Island—1 juvenile female, August 21; Losiep Island—1 male, August 22; Mangejang Island—1 female, August 20; Potangeras Island—8 males, 4 females, 4 juvenile males, 3 juvenile females, August 15, 16; Fassarai Island—3 juvenile males, 2 juvenile females, August 19.

There appears to be very little difference between the birds from the southern Marianas (*A. o. guami*) and the birds from Ulithi and

Truk (*A. o. angus*). Adult birds exhibit no marked differences in color or size. The streaked underparts of juvenile birds from the Marianas and of the single juvenile from Truk are brighter, while the juveniles from Ulithi have duller underparts. The birds from Ulithi are placed in *A. o. angus* following the Handlist of Japanese Birds, 3d ed., 1942, p. 188. The relation of these birds to *A. o. kurodai* Momiyama, from Yap, has not been ascertained, since specimens from that island are not available for examination.

Starlings were numerous at Truk Atoll. McElroy reported that the Japanese troops caught the birds for use as food. A number of very young individuals were seen in November and December. A male examined in December had enlarged testes.

At Ulithi Atoll, starlings were abundant (pl. 5, fig. 2). In August a large percent of the population had apparently just completed nesting activities, since a number of young individuals were observed being fed by adults. Most of the adults collected were in molt. Two males had enlarged testes. Stomachs contained seeds and fruit parts. The natives at Fassarai Island considered the birds to be a choice food item.

APLONIS OPACUS ORII (Takatsukasa and Yamashina)

Aplonis opaca orii Takatsukasa and Yamashina, Dobutsu. Zasshi, vol. 43, 1931, p. 458. (Coror, Pelew Islands.)

Palau Islands (Peleliu Island): Asias—1 male, August 31; Southeastern Peninsula—3 males, 2 juvenile males, 1 juvenile female, August 28, 29, 30, September 5; Ngesebus Island—1 juvenile female, September 20; Garakayo Island—2 juvenile females, September 19.

The amount of green gloss on the feathers of these specimens does not differ markedly from that found on the Ulithi birds (*A. o. angus*). As is stated in the original description, there is some difference in the depth of the bill of these races. The bill depth (at the nostril) of the Palau birds measures between 7 and 8, with one at 8.5, while the bill depth of Ulithi specimens measures between 8 and 9. Birds from the Palaus have the lower edge of the mandible generally straighter while in the Ulithi birds this lower edge curves downward slightly adding to the depth. Juvenile specimens from the Palaus have dull underparts similar to those of juveniles from Ulithi. There is no size difference between birds of the two island groups.

Many of the adults taken in August and September were in molt. Stomachs contained seeds, fruit parts, and insects.

MYZOMELA CARDINALIS SAFFORDI Wetmore

Myzomela rubratra saffordi WETMORE, Proc. Biol. Soc. Washington vol. 30, 1917, pp. 117-118. (Guam, Marianne Islands.)

Guam Island: Ritidian Point—1 male, May 30; Tarague—1 male, July 12; Pagat Point—2 males, 1 female, 1 juvenile male, July 6, 10; Yigo—1 male, May 26; Tumon Bay—2 males, 1 female, June 8, 9; Oca Point—2 males, 1 female, January 22, June 2, 3; Agaña Swamp—2 males, 1 juvenile male, June 5, 25; Piti—1 male, 1 unsexed, June 13, 28; Ylig Bay—2 males, 1 juvenile male, July 19; Agfayan Bay—1 male, 2 females, 1 juvenile female, June 6, July 7; Port Ajayan—1 juvenile female, June 19; Achang Bay—2 males, 1 female, 1 juvenile male, June 18, 19. Rota Island: Sosan Isthmus—1 male, 1 juvenile male, October 19.

Honey-eaters were found in open woodland and in the coconut groves (pl. 6). One pair of birds was found nesting in a tall banyan tree on June 16. Many of the specimens collected in the period from May to November were in molt, although several birds with enlarged gonads were taken in June and July. Weights of birds from Guam are: 17 adult males 12.7-18.0 (15.0), and 5 adult females 10.4-15.0 (12.7).

MYZOMELA CARDINALIS KOBAYASHII Momiyama

Myzomela cardinalis kobayashii MOMIYAMA, Birds of Micronesia, 1922, p. 19. (Pelew Islands.)

Palau Islands (Peleliu Island): Southeastern Peninsula—5 males, 2 females, 2 juvenile males, 2 unsexed, August 29, 30, 31, September 1, 5.

Three males collected had enlarged testes. Stomach contents included plant parts and seeds.

MYZOMELA CARDINALIS MAJOR Bonaparte

Myzomela major BONAPARTE, Compt. Rend. Acad. Sci. Paris, vol. 38, 1854, p. 263. (Caroline Islands = Truk.)

Truk Islands: Moen Island—1 male, December 13.

McElroy found honey-eaters on all islands visited. Three males examined in December had enlarged testes.

ZOSTEROPS CONSPICILLATA CONSPICILLATA (Kittlitz)

Dicaeum conspicillatum KITTLITZ, Kupfert. Naturg. Vögel, vol. 2, 1832, p. 15, pl. 19, fig. 1. (Guam.)

Guam Island: Ritidian Point—5 males, 1 female, 2 juvenile males, 1 unsexed, May 29, 30, June 28, July 12; Tarague—1 male, 1 unsexed, July 12, 18; Agaña Swamp—4 males, 2 females, 3 unsexed, June 2, 3, 25, October 8; Pago River—1 male, July 23; Agat—1 male, July 26.

At Guam, the white-eye appeared restricted to certain areas on the island. Birds were taken at five localities, where they were found in small groups moving about in low trees. No evidence of nesting activity was found although three males taken in June and July had enlarged testes. It is possible that nesting may be concentrated in the winter and spring months, though Seale (Occ. Pap. B. P. Bishop Mus., vol. 1, 1901, p. 58) recorded three nests apparently found in May, June, or July. Hartert (Nov. Zool., vol. 5, 1898, p. 57) recorded several nests taken in February and March. Six specimens taken in June and July were in molt. Weights of 11 adult males are 9.5-14.0 (10.5), of 3 adult females 8.0-10.0 (9.3).

ZOSTEROPS CONSPICILLATA ROTENSIS Takatsukasa and Yamashina

Zosterops semperi rotensis Takatsukasa and Yamashina, Dobutsu. Zasshi, vol. 43, 1931, p. 486. (Rota.)

Rota Island: Sosan Isthmus—2 males, 1 female, October 18, 20; Mariiru Point—1 juvenile male, 1 unsexed, October 22.

I am following Stresemann (Mitt. Zool., vol. 17, 1931, p. 227) in placing all the Micronesian bridled white-eyes in this one species. It is evident, however, that these races fall into rather distinct groups. *Zosterops c. conspicillata* at Guam and *Z. c. saipani* Dubois at Saipan and Tinian have a pale chin and throat, a light-colored fronto-loral band, which is very well marked in the form at Guam, and a broad white orbital ring. *Z. c. rotensis* from Rota, *Z. c. semperi* from the Palaus, *Z. c. owstoni* from Truk, and *Z. c. takatsukasai* Momiyama from Ponapé have a bright yellow chin and throat, matching the rest of the underparts, an obscure fronto-orbital band narrowly tinged with yellow, and a small white orbital ring. *Z. c. hypolais* Hartlaub and Finsch appears, from a study of the original description, to fall into another group, but no specimens are available for examination.

At Rota, white-eyes were numerous. The specimens collected were in molt.

ZOSTEROPS CONSPICILLATA SEMPERI Hartlaub

Zosterops semperi Hartlaub, Proc. Zool. Soc. London, 1868, p. 117. (Pelew Islands.)

Palau Islands: Garakayo Island—2 males, 1 female, 1 unsexed, September 18, 19.

Bridled white-eyes were found at only one locality at Garakayo Island. Small flocks were found feeding in low trees at the edge of a cliff. One male had enlarged testes. The other birds collected were in molt.

ZOSTEROPS CONSPICILLATA OWSTONI Hartert

Zosterops semperi owstoni Hartert, Nov. Zool., vol. 7, 1900, p. 2. (Ruk, Central Carolines.)

McElroy found these birds in upland areas at Moen and Udot Islands. Specimens collected were lost in shipment.

ZOSTEROPS CINEREA FINSCHII (Hartlaub)

Tephras finschii Hartlaub, Proc. Zool. Soc. London, 1868, p. 6, pl. 3. (Pelew Islands.)

Palau Islands (Peleliu Island): Eastern Peninsula—2 males, 2 females, August 27; small island off Eastern Peninsula—1 male, September 10; Garakayo Island—1 male, 5 females, September 18.

Of the three species of white-eyes observed in the southern Palaus by our field party, this bird was the most numerous. It was seen in small flocks on forest edges. Most of the specimens collected were in molt. Stomachs contained small seeds.

RUKIA PALAUENSIS (Reichenow)

Cleptornis palauensis Reichenow, Journ. Orn., 1915, p. 125. (Babeldzuap = Babelthuap, Palau Islands.)

Palau Islands (Peleliu Island): Eastern Peninsula—2 males, August 27, September 7; Southeastern Peninsula—3 males, 3 females, August 29, 30, September 4, 5, 6.

These birds were found in the undisturbed jungle areas at Peleliu. They were observed as singles and did not have the gregarious habits characteristic of the other two species of white-eyes found in the Palaus. One male had enlarged testes; some of the other specimens were in molt. Stomachs contained insects and plant parts.

ERYTHRURA TRICHROA CLARA Takatsukasa and Yamashina

Erythrura trichroa clara Takatsukasa and Yamashina, Tori, vol. 32, 1931, p. 110. (Ruk, Central Carolines.)

Truk Islands: Moen Island—1 female, December.

McElroy found these birds at three localities on Moen Island in heavy vegetation along streams. The birds were seen in small flocks. One male examined in December had enlarged testes. No birds of this species were seen at Palau.

Iwo Jima Showing Mount Suribachi

Official U. S. Navy photograph.

1. FALALOP ISLAND, ULITHI ATOLL, SHOWING THE AMOUNT OF CLEARING OF THE SMALL ISLAND FOR MILITARY INSTALLATIONS

Official U. S. Navy photograph.

2. WOODLANDS ALONG A BEACH AT PELELIU

1. MANGROVE SWAMP AT PELELIU. USED BY PHALACROCORAX MELANOLEUCOS AND NYCTICORAX CALEDONICUS

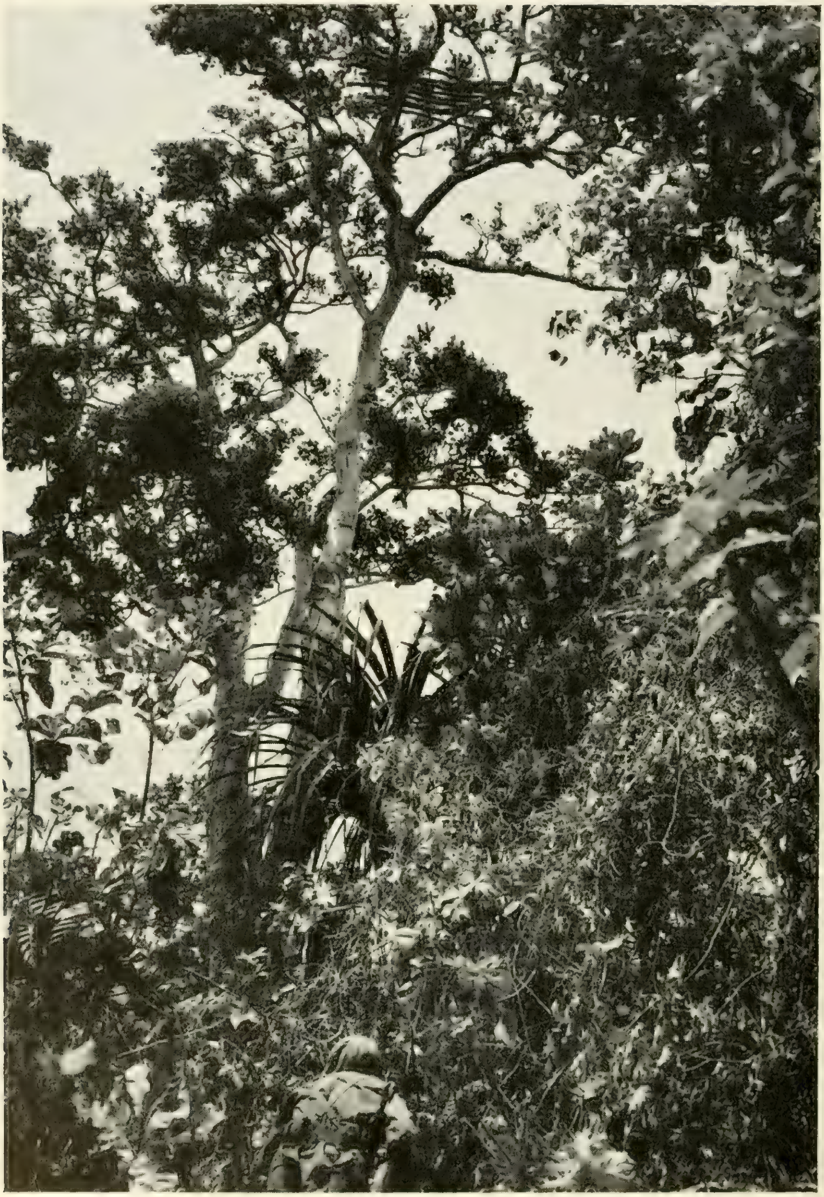
2. BRACKISH-WATER MARSH ON PELELIU ISLAND. USED BY GALLINULA CHLOROPUS

1. EXTENSIVE TIDAL FLAT AT PELELIU, USED BY MIGRATORY SHORE BIRDS

2. MYIAGRA FREYCINETI ON NEST IN BAMBOO CLUMP, MOUNT SANTA ROSA, GUAM

1. Vegetation Covering Devastated Battle Area, Peleliu Island, 1 Year Following the Invasion

2. Jungle Vegetation on Potangeras Island, Ulithi Atoll, Used by Aplonis opacus and Gygis alba



OPEN JUNGLE, TYPICAL OF THE SOUTHERN MARIANAS
Official U. S. Marine Corps photograph.

SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 107, NUMBER 16

CHARLES T. SIMPSON'S TYPES IN THE MOLLUSCAN GENUS LIGUUS

(With One Plate)

BY
FREDERICK M. BAYER
Assistant Curator, Division of Marine Invertebrates
U. S. National Museum
formerly
Research Assistant, Biological Museum of the
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Charles Torrey Simpson collected his first *Liguus* in the year 1885, and in the following 30 years made an extensive collection of these snails. He tramped many times from Key Largo to Key West and back, along the Overseas Railway, collecting on every island and in every hammock along the way. In addition, he collected in Cuba and in Haiti, gathering material on the variation and distribution of the various species and races of *Liguus*. He also was well acquainted with most of the early collectors, who materially aided him with information and with specimens from their own cabinets. In this way, Dr. Simpson became as familiar with the tree snails as was any other student at that time.

When his review of the genus [1] was published in 1929, Dr. Simpson saw that the tree snails in Florida were fighting a losing battle for existence, and that those in Cuba were being exterminated over great areas. His fears that the genus might become extinct have come close to realization, for today many of the forms have been so extensively collected as to be nearly, if not quite, extinct. The hammocks have been cleared, and even where the snails have not been deliberately collected, they have been wiped out as innocent bystanders. Great tracts of land, such as Paradise Key, Pinecrest, and areas near The Big Cypress, have been subject to devastating fires, due, at least in part, to man's interest in draining the vast Everglades. Other areas are being exploited for their timber, and this process clears the land, which promotes evaporation and thus hastens the drying and burning sequence. All these factors are contributing to the destruction of these arboreal mollusks in Florida, their only native habitat within the United States.

[1] The Florida tree snails of the genus Liguus. Proc. U. S. Nat. Mus., vol. 73, art. 20, pp. 1-44, 4 col. pls., 1929.

Many varieties of *Liguus* are now living in hammocks far outside of their original ranges, having been carried thence by collectors desirous, perhaps, of saving a choice race. As a result, distribution records made within the last few years mean relatively little; but Dr. Simpson's data, collected before this widespread transplanting had begun, gave him an excellent conception of variation, relationship, distribution, and sources of stock.

During the years Dr. Simpson spent in the study of *Liguus,* he recognized as new 18 varieties to which he assigned names. Of these, 16 are now generally accepted as valid forms. He likewise noticed, but did not name, the form subsequently called *splendidus* by Frampton, referring to it as the "form . . . ." which ". . . . has broad, brown, zigzag stripes."

Certain discrepancies have been noted between the measurements given in the original descriptions and those published in 1929, and it was therefore considered advisable to remeasure the types, with regard to a high degree of accuracy. This has been done, using vernier type calipers, and the resulting dimensions are given in this paper. The careful observer also will note certain discrepancies with respect to the specimen figured as "the type" in a few cases, and the question might easily arise as to just what specimen the type might be. However, by careful examination of the figures and descriptions, and comparison of specimens, the identity of each type has been established in all cases except one (*crassus*) that seems to be lost. In each instance, the final decision coincides with those labeled "type" in Dr. Simpson's own hand.

Some of the types are figured in a popular account of south Florida [2] published in 1920. Others are illustrated in the 1929 monograph, while one, *Liguus fasciatus castaneus,* has not been previously shown, neither of the specimens figured in the monograph being the type.

Since the figures of the types are located in volumes now practically unobtainable, we have gathered them together on one plate, with the hope that they will be of interest to students of the genus.

It is also desirable to confirm the presence of these types in the Biological Museum of the University of Miami. It is very gratifying to know that they are at last in a place of safety, and have suffered only one loss.

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[2] Simpson, C. T., In Lower Florida Wilds. G. P. Putnam's Sons, New York, 1920.

The nomenclature adopted in this paper is in accordance with Pilsbry's [3] most recent decisions on the matter. His system recognizes most of the forms thrown unconditionally into the synonymy by other authors, taking into consideration the fact that many are the end points in variation of the same subspecies. Although the majority intergrade perfectly, the extremes are easily recognizable, and are worthy of a certain degree of systematic distinction. Naturally, several of Simpson's "subspecies" fall into this category. It is not the purpose of this paper to discuss the validity of these forms, however, and those interested in the taxonomic complexities are referred to Pilsbry's excellent monograph.

The publication of the accompanying color plate of *Liguus* types has been possible only through the unlimited generosity of the University of Miami, and I am deeply indebted to Dr. Jay F. W. Pearson, vice president, and to Dr. E. Morton Miller, chairman of the zoology department, not only for making this paper possible, but for hearty encouragement as well. I also wish to thank Dr. Harald A. Rehder, curator of mollusks of the United States National Museum, for checking the manuscript, and for making many necessary arrangements connected with its publication.

LIGUUS FASCIATUS SOLIDUS variety PSEUDOPICTUS Simpson, 1920

Plate 1, figure 1, the type

Liguus solidus pseudopictus Simpson, 1920, Proc. Biol. Soc. Washington, vol. 33, p. 122.

Type figure.—Proc. U. S. Nat. Mus., vol. 73, art. 20, pl. 1, fig. 9.
Dimensions.—Length 50 mm., diameter 25 mm.
Type locality.—Lower Matecumbe Key, Fla. (upper end of island).
Range.—Lower Matecumbe Key.

LIGUUS FASCIATUS GRAPHICUS variety DELICATUS Simpson, 1920

Plate 1, figure 2, the type

Liguus solidus delicatus Simpson, 1920, Proc. Biol. Soc. Washington, vol 33, p. 122.

Type figure.—Proc. U. S. Nat. Mus., vol. 73, art. 20, pl. 1, fig. 4.
Dimensions.—Length 39 mm., diameter 21 mm.
Type locality.—Lower Matecumbe Key, Fla. (upper end of island).
Range.—Upper and Lower Matecumbe, and Indian Keys, Fla.

[3] Pilsbry, Henry A., Land Mollusca of North America (north of Mexico), vol. 2, pt. 1. Acad. Nat. Sci. Philadelphia, Monogr. No. 3, 1946.

LIGUUS FASCIATUS LOSSMANICUS variety LUTEUS Simpson, 1920

Plate 1, figure 3, the type

Liguus crenatus luteus Simpson, 1920, Proc. Biol. Soc. Washington, vol. 33, p. 123.

Type figure.—Proc. U. S. Nat. Mus., vol. 73, art. 20, pl. 3, fig. 12.

Dimensions.—Length 45 mm., diameter 24 mm.

Type locality.—Hammock along the railroad above Conch Town, Key Vaca, Fla.

Range.—Upper Keys, and peninsular Florida from Long Pine Key north to Dania.

LIGUUS FASCIATUS CASTANEOZONATUS form ROSEATUS Pilsbry, 1912

Plate 1, figure 4, the type of *livingstoni* Simpson
Plate 1, figure 7, the type of *lineolatus* Simpson

Liguus fasciatus livingstoni Simpson, 1920, Proc. Biol. Soc. Washington, vol. 33, p. 124.

Type figure.—Proc. U. S. Nat. Mus., vol. 73, art. 20, pl. 2, fig. 3.

Dimensions.—Length 48 mm., diameter 25 mm.

Type locality.—Brickell Hammock, Miami, Fla.

Range.—Miami area, peninsular Florida.

Liguus fasciatus lineolatus Simpson, 1920, Proc. Biol. Soc. Washington, vol. 33, p. 125.

Type figure.—"In Lower Florida Wilds," frontispiece, fig. 2.

Dimensions.—Length 50 mm., diameter 24.5 mm.

Type locality.—Totten's Key, Fla.

Range.—Vaca group of the Upper Keys; all the Upper Keys from Upper Matecumbe to and including Elliott's Key; mainland from Marco south to Cape Sable; south shore of the mainland. (Simpson.)

LIGUUS FASCIATUS CASTANEOZONATUS variety MIAMIENSIS Simpson, 1920

Plate 1, figure 5, the type

Liguus fasciatus miamiensis Simpson, 1920, Proc. Biol. Soc. Washington, vol. 33, p. 124

Type figure.—Proc. U. S. Nat. Mus., vol. 73, art. 20, pl. 2, fig. 4.

Dimensions.—Length 45 mm., diameter 25.5 mm.

Type locality.—Miami Hammock (Brickell Hammock), Miami, Fla.

Range.—Ojus south and west along the rocky ridge to Paradise Key. (Simpson.)

LIGUUS FASCIATUS CASTANEOZONATUS form ALTERNATUS Simpson, 1920

Plate 1, figure 6, the type

Liguus fasciatus alternatus SIMPSON 1920, Proc. Biol. Soc. Washington, vol. 33, p. 123.

Type figure.—"In Lower Florida Wilds," frontispiece, fig. 8. Proc. U. S. Nat. Mus., vol. 73, art. 20, pl. 2, fig. 1.

Dimensions.—Length 40 mm., diameter 20 mm.

Type locality.—Timm's Hammock, Fla.

Range.—Timm's Hammock; Black Creek, Paradise Key, all in Lower Dade County, Fla. "This form . . . . seems to be confined to a few localities in the south end of the mainland of the state." (Simpson.)

LIGUUS FASCIATUS CASTANEOZONATUS variety ELEGANS Simpson, 1920

Plate 1, figure 8, the type

Liguus fasciatus elegans SIMPSON, 1920, Proc. Biol. Soc. Washington vol. 33, p. 124.

Type figure.—"In Lower Florida Wilds," frontispiece, fig. 5.

Dimensions.—Length 41.5 mm., diameter 21.5 mm.

Type locality.—13 miles southwest of Paradise Key, Fla.

Range.—A small key east of Whitewater Bay, where this and *roseatus* were the only form(s) of *Liguus;* small hammock on Long Pine Key, one very large specimen; Paradise Key; Costello's Hammock; Miami; Arch Creek; Pinecrest. (Simpson.)

LIGUUS FASCIATUS ELLIOTTENSIS variety CAPENSIS Simpson, 1920

Plate 1, figure 9, the type

Liguus crenatus capensis SIMPSON, 1920, Proc. Biol. Soc. Washington, vol. 33, p. 122.

Type figure.—Proc. U. S. Nat. Mus., vol. 73, art. 20, pl. 3, fig. 9.

Dimensions.—Length 52.5 mm., diameter 25 mm.

Type locality.—Northwest Cape Sable, Fla.

Range.—Northwest, Middle, and East Cape Sable; hammock near Flamingo. (Simpson.)

LIGUUS FASCIATUS TESTUDINEUS form ORNATUS Simpson, 1920

Plate 1, figure 10, the type

Liguus fasciatus ornatus Simpson, 1920, Proc. Biol. Soc. Washington, vol. 33, p. 124.

Type figure.—"In Lower Florida Wilds," frontispiece, fig. 4.
Dimensions.—Length 38 mm., diameter 22 mm.
Type locality.—Paradise Key, Fla.
Range.—Long Pine Key and hammocks along the rocky ridge to the Miami River. (Simpson.)

LIGUUS FASCIATUS ELLIOTTENSIS variety VACAENSIS Simpson, 1920

Plate 1, figure 11, the type

Liguus crenatus vacaensis Simpson, 1920, Proc. Biol. Soc. Washington, vol. 33, p. 122.

Type figure.—Proc. U. S. Nat. Mus., vol. 73, art. 20, pl. 4, fig. 10.
Dimensions.—Length 54 mm., diameter 28 mm.
Type locality.—Southwest of Conch Town, Key Vaca, Fla.
Range.—Vaca Keys; Long Island; Key Largo; Angelfish Key; Sands Key; Northwest and Middle Cape Sable (?) near Flamingo (?). (Simpson.)

LIGUUS FASCIATUS ELLIOTTENSIS variety EBURNEUS Simpson, 1920

Plate 1, figure 12, the type

Liguus crenatus eburneus Simpson, 1920, Proc. Biol. Soc. Washington, vol. 33, p. 122.

Type figure.—"In Lower Florida Wilds," frontispiece, fig. 10.
Dimensions.—Length 44 mm., diameter 24 mm.
Type locality.—Timm's Hammock, Fla.
Range.—Hammocks along the rocky mainland ridge from Long Pine Key to Lemon City and opposite it on the peninsula. (Simpson.)

LIGUUS FASCIATUS TESTUDINEUS variety CASTANEUS Simpson, 1920

Plate 1, figure 13, the type

Liguus fasciatus castaneus Simpson, 1920, Proc. Biol. Soc. Washington, vol. 33, p. 126.

Type figure.—Plate 1, figure 13, herewith.
Dimensions.—Length 38 mm., diameter 21 mm.
Type locality.—Paradise Key, Fla.
Range.—Miami to Long Pine Key. (Simpson.)

LIGUUS FASCIATUS ELLIOTTENSIS variety CINGULATUS Simpson, 1920

Plate 1, figure 14, the type

Liguus crenatus cingulatus SIMPSON, 1920, Proc. Biol. Soc. Washington, vol. 33, p. 123.

Type figure.—Proc. U. S. Nat. Mus., vol. 73, art. 20, pl. 3, fig. 6.
Dimensions.—Length 39.5 mm., diameter 21.5 mm.
Type locality.—Brickell Hammock, Miami, Fla.
Range.—Long Island of the Upper Keys; Key Largo; Middle Cape Sable; East Cape Sable; Flamingo; Long Pine Key (?); Timm's Hammock; Lysiloma Hammock, both in Lower Dade County; Miami; Lemon City. (Simpson.)

LIGUUS FASCIATUS LOSSMANICUS variety MOSIERI Simpson, 1920

Plate 1, figure 15, the type

Liguus crenatus mosieri SIMPSON, 1920, Proc. Biol. Soc. Washington, vol. 33, p. 123.

Type figure.—Proc. U. S. Nat. Mus., vol. 73, art. 20, pl. 4, fig. 2.
Dimensions.—Length 45 mm., diameter 24 mm.
Type locality.—Brickell Hammock, Miami, Fla.
Range.—Hammocks from Arch Creek southward and westward along the great rocky mainland ridge to Long Pine Key, being most abundant at Miami, the type locality. (Simpson.)

LIGUUS FASCIATUS GRAPHICUS form SIMPSONI Pilsbry, 1921

Plate 1, figure 16, the type of *lineatus* Simpson

Liguus solidus lineatus SIMPSON, 1920, Proc. Biol. Soc. Washington, vol. 33, p. 121, non *Achatina lineata* Valenciennes 1833.
Liguus fasciatus simpsoni PILSBRY, 1921, Nautilus, vol. 34, p. 140.

Type figure.—"In Lower Florida Wilds," frontispiece, fig. 3 (*lineatus*).
Dimensions.—Length 40 mm., diameter 22 mm.
Type locality.—Lignumvitae Key, Fla. (north side of island).
Range.—Lignumvitae and Lower Matecumbe Keys, Fla. (Simpson.)

LIGUUS FASCIATUS TESTUDINEUS variety VERSICOLOR Simpson, 1920

Plate 1, figure 17, the type

Liguus fasciatus versicolor SIMPSON, 1920, Proc. Biol. Soc. Washington, vol. 33, p. 125.

Type figure.—"In Lower Florida Wilds," frontispiece, fig. 12.
Dimensions.—Length 38.5 mm., diameter 21.5 mm.
Type locality.—Big Hammock, Long Island Key, Everglades, Fla.
Range.—Confined to Long Pine Key according to Simpson.

LIGUUS FASCIATUS GRAPHICUS variety CRASSUS Simpson, 1920

The type and one additional specimen, the only material of this variety, have both been lost since Dr. Simpson's death.

EXPLANATION OF THE PLATE

Fig. 1. *Liguus fasciatus solidus* variety *pseudopictus* Simpson.
2. *Liguus fasciatus graphicus* variety *delicatus* Simpson.
3. *Liguus fasciatus lossmanicus* variety *luteus* Simpson.
4. *Liguus fasciatus castaneozonatus* form *roseatus* Pilsbry, the type of Simpson's *livingstoni*.
5. *Liguus fasciatus castaneozonatus* variety *miamiensis* Simpson.
6. *Liguus fasciatus castaneozonatus* form *alternatus* Simpson.
7. *Liguus fasciatus castaneozonatus* form *roseatus* Pilsbry, the type of Simpson's *lineolatus*.
8. *Liguus fasciatus castaneozonatus* variety *elegans* Simpson.
9. *Liguus fasciatus elliottensis* variety *capensis* Simpson.
10. *Liguus fasciatus testudineus* form *ornatus* Simpson.
11. *Liguus fasciatus elliottensis* variety *vacaensis* Simpson.
12. *Liguus fasciatus elliottensis* variety *eburneus* Simpson.
13. *Liguus fasciatus testudineus* variety *castaneus* Simpson.
14. *Liguus fasciatus elliottensis* variety *cingulatus* Simpson.
15. *Liguus fasciatus lossmanicus* variety *mosieri* Simpson.
16. *Liguus fasciatus graphicus* form *simpsoni* Pilsbry, the type of Simpson's *lineatus*.
17. *Liguus fasciatus testudineus* variety *versicolor* Simpson.

CHARLES T. SIMPSON'S TYPES IN THE MOLLUSCAN GENUS LIGUUS

(For explanation, see p. 8.)

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INHIBITION OF PLANT GROWTH BY EMANATIONS FROM OILS, VARNISHES, AND WOODS

(With Eight Plates)

BY
ROBERT L. WEINTRAUB
AND
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Division of Radiation and Organisms
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Smithsonian Institution

(With Eight Plates)

While attempting to culture oat seedlings in a tightly closed growth chamber constructed from ponderosa pine and hardboard (Masonite Tempered Presdwood),[2] a very marked retardation or arrestment of development was observed. Inasmuch as the plants were not in direct contact with the growth chamber and as normal seedling development was found concurrently in a variety of other containers under identical conditions of temperature, humidity, light, and substrate, the inhibitory effect seemed to be attributable to an emanation from the box. Production or liberation of the active agent was found to continue over a long period of time as inhibition resulted consistently, in undiminished degree, in several trials over a period of some months, despite repeated and prolonged ventilation of the chamber.

This observation seemed to be of sufficient interest to warrant further exploratory experiments on various aspects of the phenomenon.

DESCRIPTION OF PLANT RESPONSE

Air-dry "seeds" planted on a moist germination substrate[3] and placed at once in the box imbibed water readily and development

[1] Now with the Department of the Army, Camp Detrick, Frederick, Md.

[2] The inside dimensions of the box were 91 × 38 × 36 cm., giving a volume of approximately 124,000 cm.^{3}. The area of the inner pine surface was 9,200 cm.^{2}, and of the inner Presdwood surface 6,900 cm.^{2}, or a total of 16,100 cm.^{2}. Prior to use, the interior of the box had been brush-coated with two layers of varnish and allowed to dry thoroughly.

[3] Porous silica wicks (obtainable from Filtros Incorporated, East Rochester, N. Y.) wrapped in filter paper and partially immersed in distilled water contained in finger bowls, as illustrated in plate 1, were used in most of the experiments.

appeared to be initiated normally but, in most plants, ceased completely when the radicles and coleoptiles attained lengths of about a millimeter. Seedlings in this arrested condition could be kept in the chamber as long as 5 weeks without any apparent change. The inhibition was rapidly and completely terminated, however, by transferring the plants to other containers constructed of glass, copper, galvanized iron, or tin plate; after such transfer the seedlings promptly resumed development at a rate at least as great as normal. (See pl. 1.)

Preliminary tests with other species indicated that wheat and corn are affected very much like oats; the germination of sorghum, barley, tomato, bean, lettuce, and radish was also decreased or retarded, but the inhibition was less pronounced than in the foregoing.

In subsequent experiments with oats, described below, it proved possible to achieve a greater degree of inhibition such that even the incipient germination was suppressed. This suggests that the initial development of seeds in the original growth chamber may have been permitted by a lower concentration of inhibitor prevailing at the outset of an experiment, as opening the box necessarily permitted some ventilation.

The susceptibility of the seedlings decreases after the earliest stages of development. Thus, seeds which were allowed to germinate for 2 days in a control chamber and were then transferred to the toxic box exhibited relatively little subsequent retardation, whereas marked inhibition resulted when the foreperiod was 24 hours or less. The result of a similar experiment is shown in plate 2.

Inhibition occurs both in light and in darkness, and on the silica wicks either with or without filter paper. The effect was not found, however, if the seeds were planted on soil or on an agar-water gel (pl. 3).

SOURCE OF THE INHIBITORY EMANATION

The materials of the growth chamber which could be implicated as sources of the emanation were the varnish, the hardboard, and the pine wood.

Varnish.—The particular lot of varnish which had been used in coating the original box was no longer available, but experiments were made with five other brands from different manufacturers; these were tested as dried films on cardboard panels which were enclosed with dishes of seeds in metal containers. All were found to retard seedling development to some extent although in no case was the effect as great as that originally observed. Similar results (pl. 4) were obtained with films prepared from various vegetable oils (linseed, soybean, safflower, and castor) containing lead and cobalt naphthenates as driers. A layer of linoleic acid also was found to cause some retardation of growth; its effectiveness could be increased by exposure, in an open dish, to daylight for several hours prior to the test. Oleic acid, which is less unsaturated than linoleic, had very little inhibitory activity.

These tests indicated that varnishes, vegetable oils, and unsaturated fatty acids give rise to emanations which retard seedling development.[4] However, the effects observed were less marked than those found in the toxic growth chamber, and while the possibility was considered that the difference might be due to more rapid production of the active agent from the original varnish, it seemed desirable to make further tests of the other materials of the box.

Wood.—Accordingly the varnish was removed mechanically from the box with a cabinet scraper; the inhibitory activity was not diminished thereby but rather seemed to be somewhat enhanced. A second box was then built entirely of pine boards (not certainly identified as to species but belonging to the yellow-pine group) which had never been varnished; in this box the inhibition was unmistakably greater than in the first, germination being completely suppressed.

An experiment was next set up in which 10 other species of wood were tested in the form of small pieces of well-seasoned board in desiccators or bell jars. All proved to exert a marked inhibitory action (pl. 5).

All these tests were essentially qualitative, the appearance of the seeds or seedlings being deemed a sufficient criterion of the occurrence of inhibition. It was not thought worth while to attempt to develop a more quantitative measure of inhibition until the factors influencing production and action of the inhibitor were better understood. Furthermore, as the wood samples employed in the previously described experiment were obtained from scraps of lumber of uncertain history, scant significance would appear to attach to the relative effectiveness of the different woods. What relation may exist between the amount of wood present and the magnitude of the inhibition has not been ascertained. Data on weights, volumes, and surfaces of the samples used are presented in table 1.

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[4] On the basis of our previous experience with culture of oat seedlings we can conclude that the decrease in oxygen content and increase in carbon dioxide content of the atmosphere (which accompany autoxidation of drying oils and unsaturated fatty acids in closed containers) were much too small, under the existing conditions, to have been of significance as factors in the inhibitory action.

In another experiment, one dish of seeds was placed in a 13-liter desiccator with three pieces of spruce board (total 358 g.) and a second set enclosed in a similar container with an equal weight of small chips (prepared by running a piece of the same board over a planer set at 1/16 inch) which of course possessed a very much greater exposed surface. Both sets were inhibited equally, suggesting that the degree of inhibition is related to weight or volume of wood rather than to surface. No inhibition was found when only one-ninth the weight (40 g.) of chips was present.

TABLE 1.—*Inhibition of oat germination by emanations from various species of wood* (see also pl. 5)

Relative effectiveness	Wood	Weight of wood per cm.³ of air in container	Volume of wood per cm.³ of air	Surface of wood per cm.³ of air
		mg.	cm.³	cm.²
1	Tulip poplar	9	0.020	0.112
2	Spruce	...	...	.110
3	Red oak	126	.166	.336
4	White oak	108	.137	.282
5	Black walnut	50	.091	.228
6	Douglas fir (plyboard)	28	.048	.172
7	Poplar	48	.108	.202
8	Eastern red cedar	165	.293	.634
9	Mahogany	77	.139	.477
10	Black cherry	89	.155	.370

Hardboard.—It remained to test the Masonite Tempered Presdwood [5] such as had been used in construction of the box in which the inhibitory effect was originally observed. This material also was found to produce a toxic emanation.

IDENTITY OF THE INHIBITOR

It is well known that autoxidation of unsaturated fats and of drying oils, such as are used in the formulation of varnish, gives rise to a variety of volatile products (Friend, 1917; Hefter and Schönfeld, 1937; Gardner, 1914a; Vogel, 1930; Lea, 1938). Volatile compounds have been shown also to be present in, or produced by, wood and certain wood constituents (Wise, 1944; Schorger, 1917; King-

[5] According to the manufacturer this material is made from exploded wood fiber, chiefly of southern yellow pine. The lignocellulose fibers are refined, felted, and pressed into board form and then impregnated with a resin compound which is completely polymerized by heating.

zett and Woodcock, 1910, 1912). It has been demonstrated, further, that oxidation of various fats and fatty acids results in development of antibiotic activity [6] (Sabalitschka, 1939; Spoehr et al., 1945, 1946) and that in some instances such activity is due to volatile substances (Harris, Bunker, and Milas, 1932a, b); the reputed sanitary value of oil paints has been ascribed to production of volatile aldehydes (Gardner, 1914b; Hewitt, 1943). The vapors of a number of essential oils, too, have been found to be bactericidal or bacteriostatic (Schöbl and Kusama, 1924; Schöbl, 1925).

On the other hand, some workers have ascribed the antibiotic effects which accompany oxidation of oils to emission of radiant energy (Wrenn, 1927; Ried, 1930).

Radiation versus chemical vapor.—In order to determine whether the growth inhibition of seedlings caused by wood is due to a vapor or to radiant energy emitted by the wood the following experiments were performed.

In a metal box containing a few small boards were placed two dishes of seeds, one of which was in turn enclosed in a cell with 2.1-mm. thick windows of Corning No. 791 glass. According to the manufacturer, this glass transmits ultraviolet radiation of wave lengths greater than 2200 A. The plants exposed directly to the wood were strongly inhibited while those within the cell, which were protected from any chemical vapor arising from the wood, all developed normally (pl. 6, fig. 1). This experiment demonstrates that no appreciable part of the inhibition by wood can be due to radiation of wave lengths greater than about 2200 A., although it does not eliminate the possibility of activity by shorter wave lengths.

In the second test, dishes of seeds were placed in two similar 1.5-liter bell jars which were connected separately to a compressed-air line. Humidified air was blown through each jar at about 15 liters per hour, the air being directed onto the seeds by means of an inverted glass funnel situated immediately above them. The air supply to one jar was first passed through a metal can containing seven small pieces of board (total weight=770 g.). The plants exposed to air which had been in contact with the wood were markedly inhibited (pl. 6, fig. 2) indicating that the active agent had passed from the wood-containing can to the bell jar. As these were connected by a 40-cm. length of small-bore rubber tubing bent in a semicircle, the conclusion seems inescapable that the inhibitory agent was transmitted as vapor rather than as radiant energy.

[6] Antibiosis is here employed in its broadest sense of an action inimical to normal life processes.

In several experiments in closed vessels containing pieces of wood, a curious effect was noted. In a single population of seeds planted on a silica block of relatively small dimensions, some plants might be inhibited much more than others, but the variation was not distributed randomly through the population as would be expected if it were due to individual differences in susceptibility; rather a positional effect was manifest. That is, plants at one end of the wick might be completely checked while the growth of those at the other end would be only slightly retarded; the seedlings between exhibited an intermediate response. Examples of this behavior are illustrated in plates 2 and 5.

The explanation seems to be that the active vapor is not distributed uniformly in the air of the container. The combined influence of the slow diffusion within a closed vessel maintained at uniform temperature and the relatively rapid removal of the agent from the vapor phase results in concentration gradients within the confined space. To test this hypothesis, two wicks were arranged end to end in a jar and some pieces of board were placed near one end of one of the wicks. A rather striking gradation of inhibition, according to the distance from the wood, resulted (pl. 7, fig. 1). Similar effects are produced also by vapors of known chemicals if the locus of production of the vapor is situated unsymmetrically with respect to the seeds. This was shown unmistakably by seeds exposed to hydrogen peroxide vapor although not so clearly evident in the reproduced photograph (pl. 7, fig. 2); in this experiment, each dish of seeds was in an individual jar with dishes of hydrogen peroxide solution adjacent to the ends of the wicks shown at the right-hand side of the photograph.

Tests on vapor from wood.—Room air was humidified and drawn, by means of a water-line aspirator, through a glass tube (4 m. long, 4 cm. diameter) packed with 350 g. of spruce chips. At a flow rate of approximately 15 l. per hour this air completely checked the development of oat seeds when passed through a desiccator in which they had been planted. A similar set of seeds placed in the air stream ahead of the wood was not inhibited showing that the unaltered room air was nontoxic.

The desiccators were then replaced with gas washing bottles containing 100 ml. of boiled distilled water ($pH=7.0$) through which the air was passed as fine bubbles during a 5-day period. At the end of this time the water was found to be free of ammonia (<0.01 mg.), hydrogen peroxide (<0.1 mg.), and substances capable of oxidizing potassium iodide in acid solution. The pH of the water in the bottle following the wood had been lowered to 3.5, however, indicating absorption of an acid substance.

When the air which had passed over the chips was scrubbed through water its inhibitory potency was greatly diminished. Hence the active constituent appears to be absorbed or destroyed by water. Bubbling the air through 5N sulfuric acid did not remove the inhibitor. These results also suggest that the active component may be acidic in nature.

Inhibitory effect of various volatile compounds.—While the above-described experiments were in progress exploratory tests were made with some of the substances which might be expected to be present, in order to determine whether exposure of the seeds to the vapors would result in inhibition similar to that produced by the emanations from oils and wood. Volatile products of autoxidation of unsaturated fats include carbon dioxide, carbon monoxide, organic acids, aldehydes, and peroxides, some of which have been shown to possess a high degree of antibiotic activity.

Carbon monoxide was tested at concentrations of 1, 5, 10, 20, and 25 percent by volume in air. Retardation of germination and of root and shoot growth occurred at concentrations of 10 percent and greater, but even in 25-percent CO the inhibitory effect was much less pronounced than that caused by the emanations from wood.

For the hydrogen peroxide tests (pl. 7, fig. 2) the seeds were placed in 3-liter jars containing open dishes of aqueous H_2O_2 solutions (volume = 30 ml.; exposed surface = 125 cm.^{2}). It is estimated that air at 25° in equilibrium with 20, 50, and 90 percent solutions, respectively, contains about 0.17, 0.29, and 2.25 mg. H_2O_2 vapor per liter.

Tests of the other compounds were conducted by placing small open vials containing weighed amounts of the liquids, solids, or aqueous solutions (in the case of formaldehyde and acrylic acid) in the desiccators with seeds.

Sufficiently large dosages of several of the compounds were lethal. At lower concentrations development was arrested but could be resumed on subsequent ventilation, thus duplicating the effect of the varnishes, oils, and wood. Continued inhibition without killing appears to require a maintained supply of the vapor but the concentrations necessary for this were not closely determined. It was, of course, possible to calculate the concentrations which would have existed if all the introduced material were present as gas, but as some of the compounds vaporized slowly and as there was, in all likelihood, loss from the vapor phase by absorption, adsorption, or chemical reaction, the actual concentrations were probably considerably lower. The special apparatus and technique required in order to maintain known concentrations in the vapor phase for the 4- or 5-day duration of a test was not warranted in view of the lack of agent-specificity of the inhibition.

Of the compounds tested, the more active were: acrylic aldehyde (acrolein) (see pl. 8), crotonaldehyde, hydrogen peroxide, crotonic acid, and acrylic acid. Also effective, but at higher concentrations, were: acetic acid, propionic acid, n-butyric acid, n-valeric acid, n-butyraldehyde. At the vapor concentrations attainable, little or no inhibition was produced by enanthic acid, caprylic acid, pelargonic acid, capric acid, adipic acid, pimelic acid, or lauroyl peroxide.

Owing to the nonspecificity of the inhibition, the value of these exploratory tests with known compounds is of a negative character in that they serve to eliminate as possibilities those substances found to be relatively inactive but do not differentiate among the more effective ones.

DISCUSSION

The foregoing observations raise numerous questions regarding the nature of the volatile agent (or agents), the mechanism of its formation by diverse materials, the mode of its action on the plant, and its detoxification by some substrates. Further experimentation is required to provide the answers to these.

It cannot be stated whether a variety of antibiotic agents is evolved from varnishes, oils, unsaturated fat acids, and various species of wood, or whether these diverse materials owe their activity to production of a single compound. It seems unlikely that the agent is present as such in these materials; rather it is probably formed through oxidative processes.

From the viewpoint of the inciting materials there is a degree of similarity between the plant inhibition and the so-called "Russell effect" by which is designated the production of a latent image in a photographic emulsion in darkness by a large variety of materials, including woods, resins, terpenes, animal and vegetable oils, and unsaturated fat acids (Russell, 1897, 1898, 1899, 1904, 1906, 1908; Molisch, 1903; Schmidt, 1908; Kugelmass and McQuarrie, 1924, 1925; Baughman and Jamieson, 1925; Haxthausen, 1925; Stutz et al., 1925; Keenan, 1926; Mix, 1944). The agent responsible for this phenomenon can act at a distance, be conducted through a bent tube, and penetrate porous materials such as paper or gelatin but not glass or metals. There is some evidence that the Russell effect is due to production of hydrogen peroxide vapor, presumably as a result of oxidation of some constituent of the effective materials, although some investigators have attributed it to emission of radiant energy. However, in view of the relatively high concentration of hydrogen peroxide vapor required for inhibition of oats and of the negative test for this compound in the wood aeration experiment, it is improbable that this is the antibiotic agent.

The mechanism of action on the plant is of particular interest in view of the ready reversibility of inhibition. Continuous exposure to the vapor is necessary in order that development remain arrested; there is no evidence of a cumulative effect on prolonged exposure at the concentrations prevailing under the conditions employed. This suggests that there may be a continuous absorption and detoxification of the agent either by the plant or by the external water supply. It is not known whether the vapor is absorbed directly by the seed or must first be dissolved externally.

In contrast to the emanations from wood, the vapors of certain of the toxic chemicals which have been tested are not neutralized by soil or agar (pl. 8). Possibly this difference is merely one of degree and would not be found if the wood vapor could be supplied in greater concentrations.

That an effect so marked as the complete arrestment of development has not frequently been noted by others who have cultured seeds in small unventilated wooden or varnished containers may be due to the detoxifying action of soil, and perhaps also of other organic materials used as substrates. The literature is not devoid of references to more or less similar phenomena. Borriss (1940) presented evidence of the occurrence in air of germination-inhibiting substances whose action was nullified by the use of soil or charcoal as substrate. He believed these vapors to arise, at least in part, from the varnish of his incubators and showed that similar effects were produced by emanations from turpentine, linseed oil, and varnish. Raines (1935) reported that growth of roots was affected by vapors liberated at room temperature from paraffine, "vaseline," mineral oils, and various waxes, and Raines and Travis (1937) attributed seasonal differences in root growth under uniform conditions of light and temperature to ventilation conditions of the laboratory; it was suggested that during the winter months the air contains higher concentrations of vapors from illuminating gas, paints, oils, varnishes, etc. Possibly effects of this kind may have been involved in studies of seasonal variations in seed germination (e.g., Schmidt, 1930; Baldwin, 1935).

Abnormal curvatures, diminished elongation, and increased thickening of seedling shoots cultured in laboratory air have been noted by several investigators (Neljubow, 1901, 1911; Singer, 1903; Richter, 1903, 1906). Similar effects were shown to be produced by low concentrations of ethylene (Neljubow, and also later workers) and of vapors from terpenes and from wood (Richter, 1906).

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SUMMARY

Air in contact with certain oils, varnishes, and woods was found to acquire the property of inhibiting or markedly retarding the germination of oats, wheat, and corn, and also, to less pronounced degree, sorghum, barley, tomato, bean, lettuce, and radish. The inhibition or retardation ceased completely on removal of the seeds from the affected air. As the active agent could be transferred in an air stream from one container to another, it is considered to be of the nature of a chemical vapor rather than some form of radiant energy.

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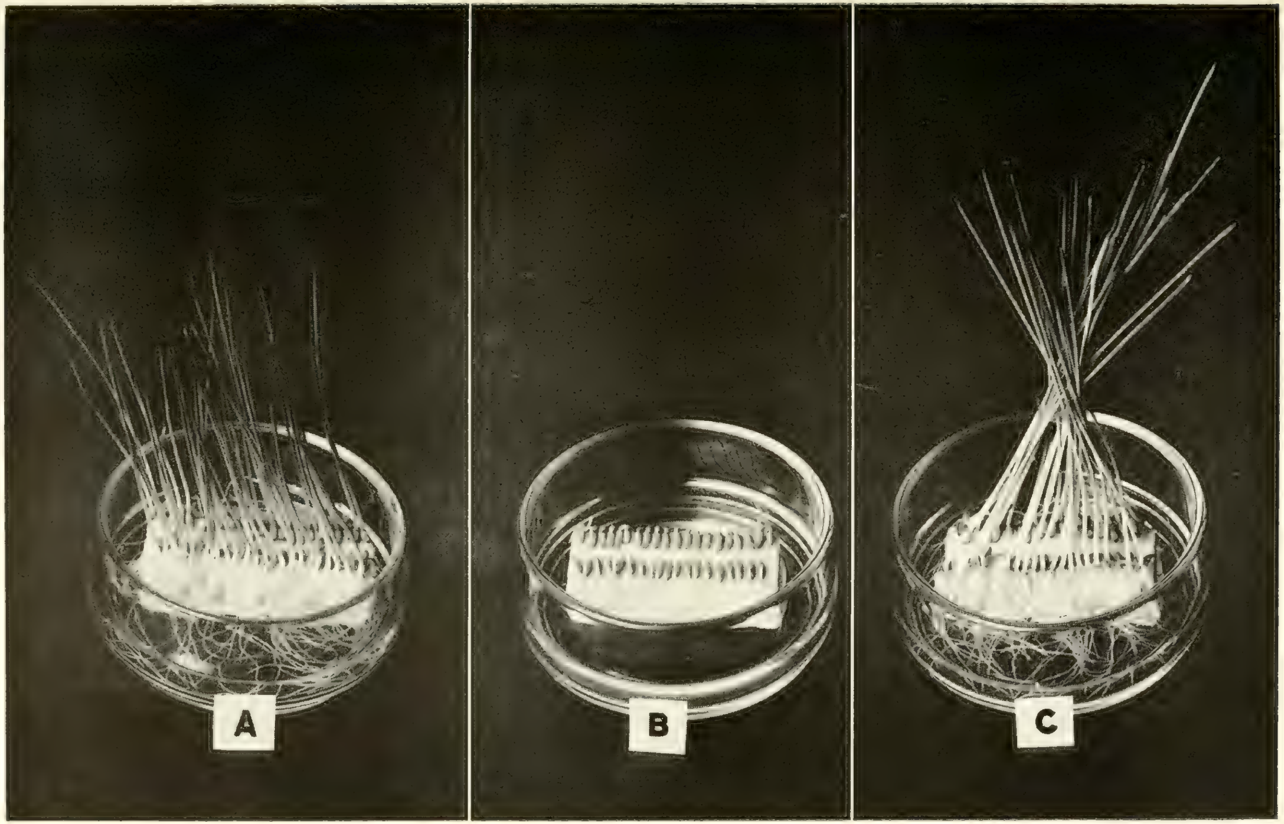
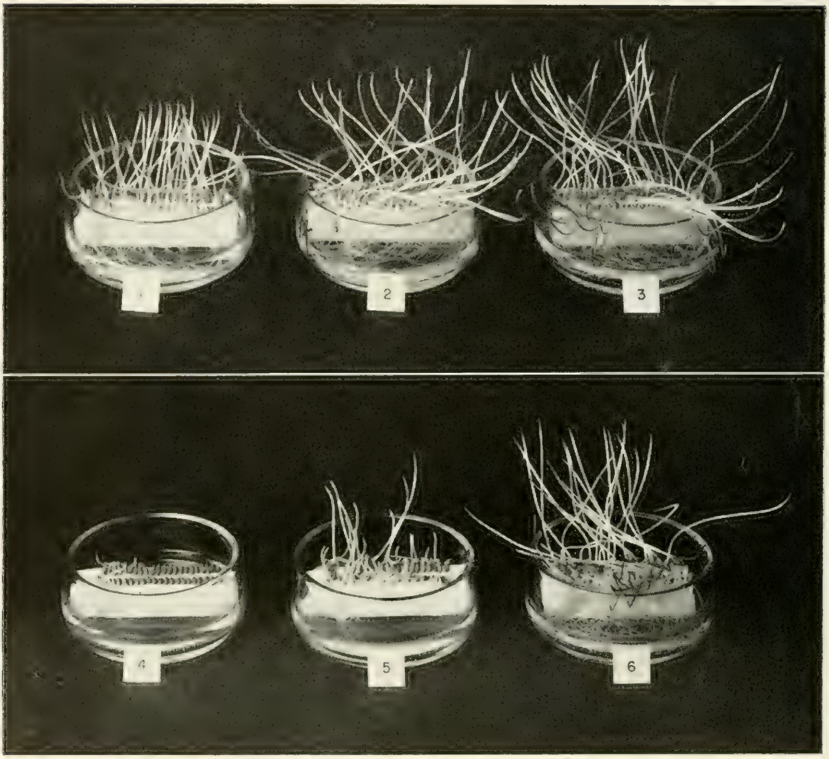


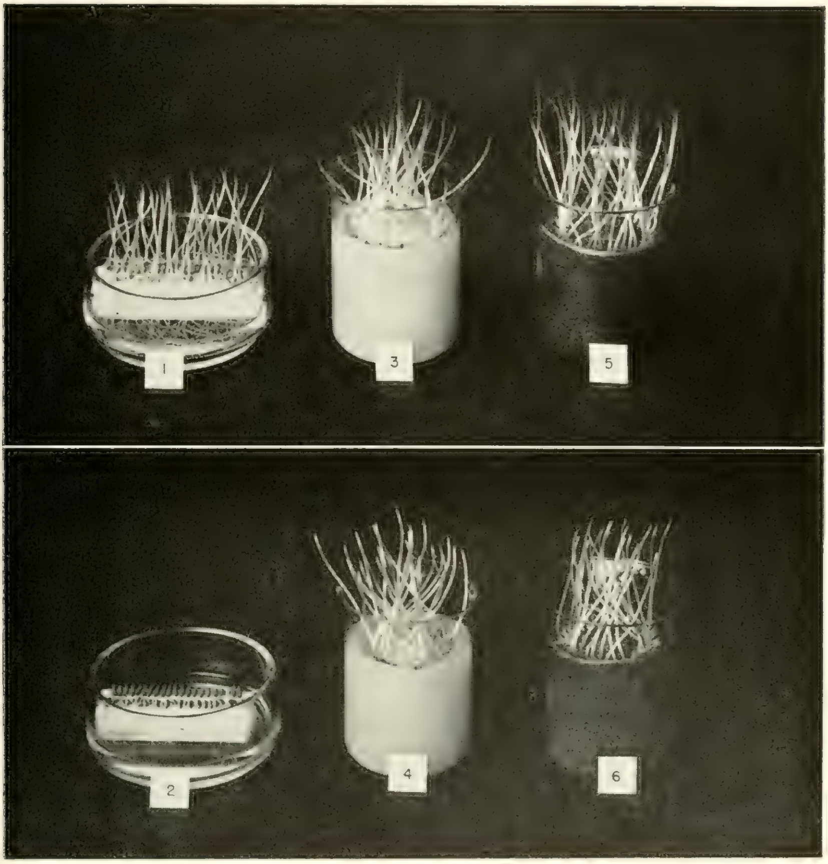
INHIBITION OF OATS BY EMANATION FROM VARNISHED BOX

A, control plants, 5 days after planting; B, planted at same time as set A and kept in varnished box 5 days; C, same plants as in B after having been transferred to control chamber for 5 days.



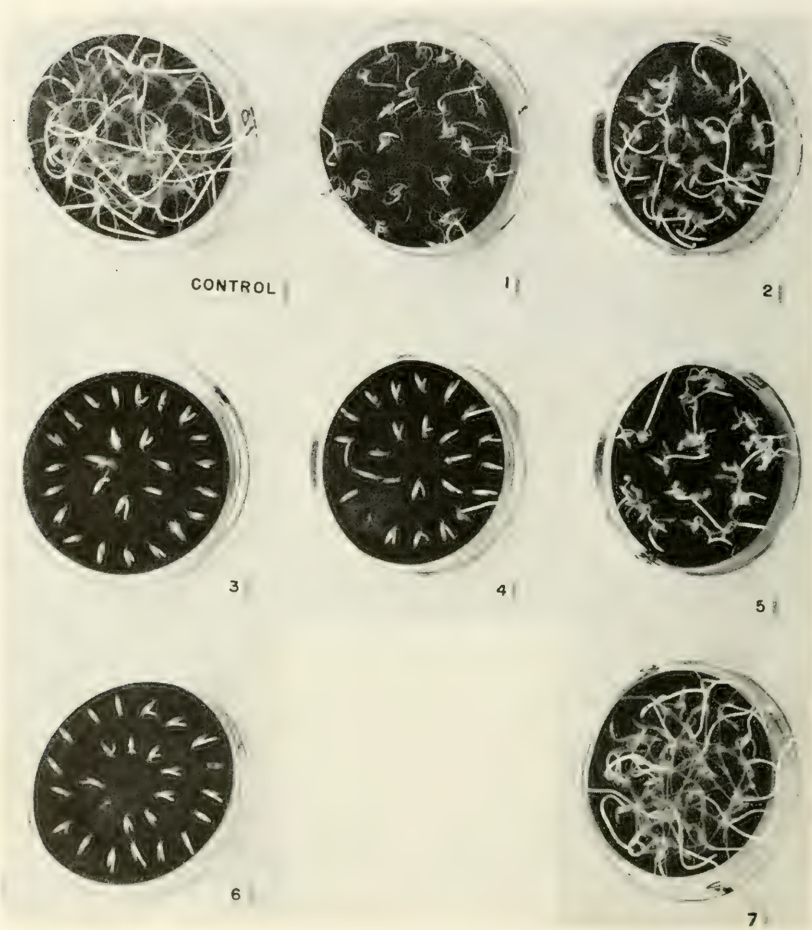
SUSCEPTIBILITY OF OAT SEEDLINGS TO EMANATION FROM WOOD AS INFLUENCED BY AGE AT EXPOSURE

1, 2, 3, controls, aged 5, 6, and 7 days, respectively; 4, age 5 days, exposed to wood from time of planting; 5, age 6 days, exposed to wood after first 24 hours; 6, age 7 days, exposed to wood after first 48 hours.



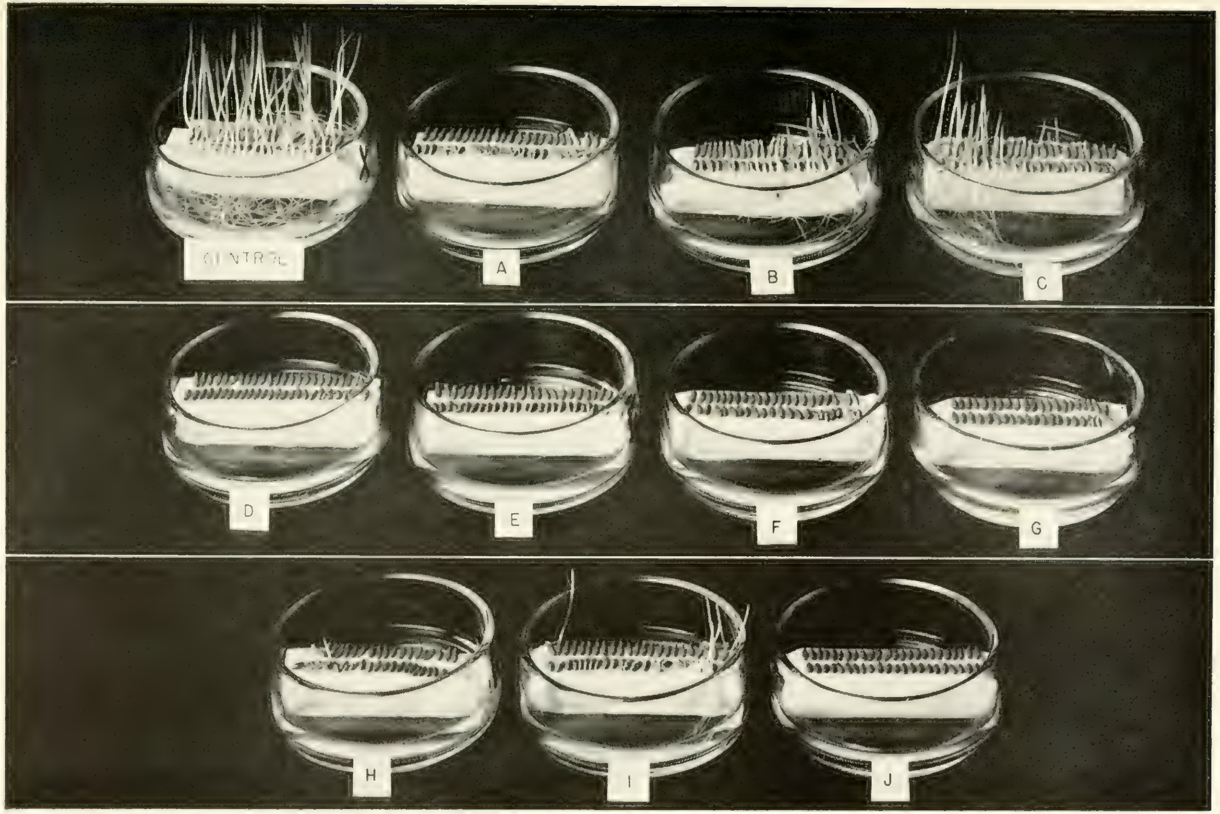
INFLUENCE OF SEED SUBSTRATE ON INHIBITION BY EMANATION FROM WOOD

1, 3, 5, controls, in 18-liter galvanized iron box; 2, 4, 6, cultured in similar box containing 7 pieces of wood (total weight = 780 g.). 1, 2, seeds planted on filter-paper-wrapped silica wicks; 3, 4, seeds planted on 1.5-percent agar gel; 5, 6, seeds planted on garden loam. Photographed 4 days after planting.



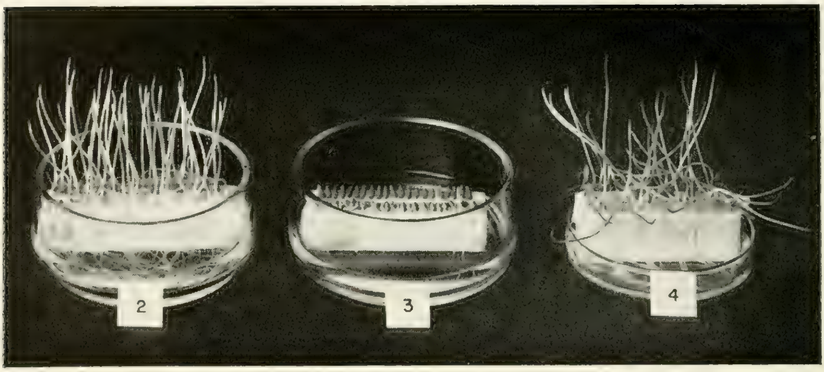
INHIBITION BY EMANATIONS FROM VEGETABLE OILS

Oat seeds planted on blotters in open dishes were cultured in closed 1-liter cans containing cardboard panels coated with various oils: 1, "Kellin"; 2, "Kellsoy"; 3, safflower oil; 4, soybean oil; 5, "Dorscolene"; 6, linseed oil; 7, castor oil. Photographed 4 days after planting.



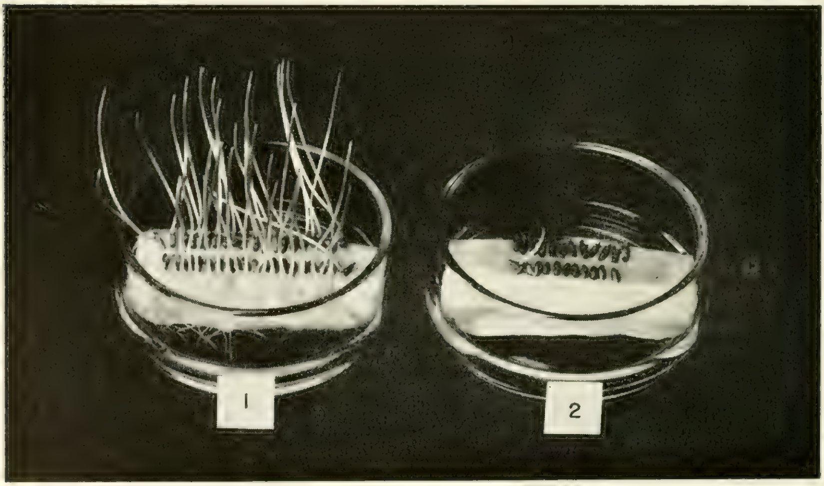
INHIBITION BY EMANATION FROM VARIOUS SPECIES OF WOOD

A, eastern red cedar; B, mahogany; C, black cherry; D, red oak; E, walnut; F, white oak; G, spruce; H, Douglas fir (plyboard); I, poplar; J, tulip poplar.



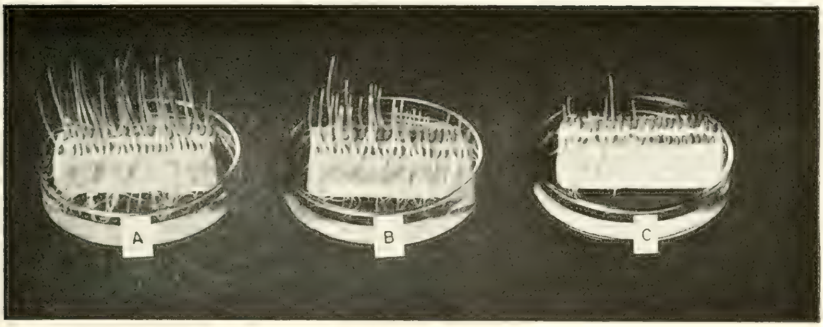
1. Opacity of Ultraviolet-transmitting Glass to Inhibitory Enamation from Wood

2, control; 3, 4, cultured in a single closed metal box containing wood. No. 3 was exposed directly to the wood, while No. 4 was further enclosed in a cell with windows of Corning # 791 glass which transmits > 2200 A. (The prostrate position of some of the shoots in No. 4 is due to their having been dislocated on removal from the cell.) Photographed 4 days after planting.



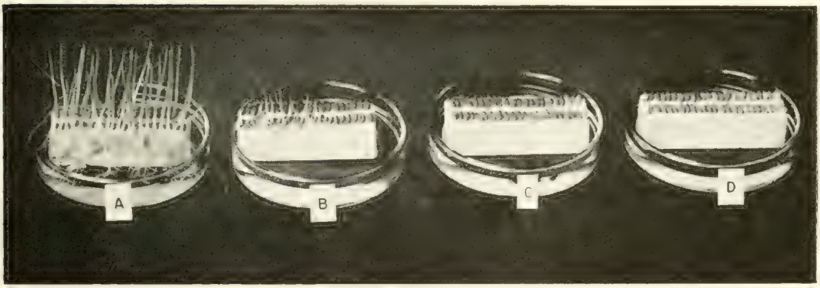
2. Inhibition by Vapor from Wood

1, control, aerated directly from compressed-air line; 2, exposed to air stream which was first passed through can containing wood. Photographed 4 days after planting.



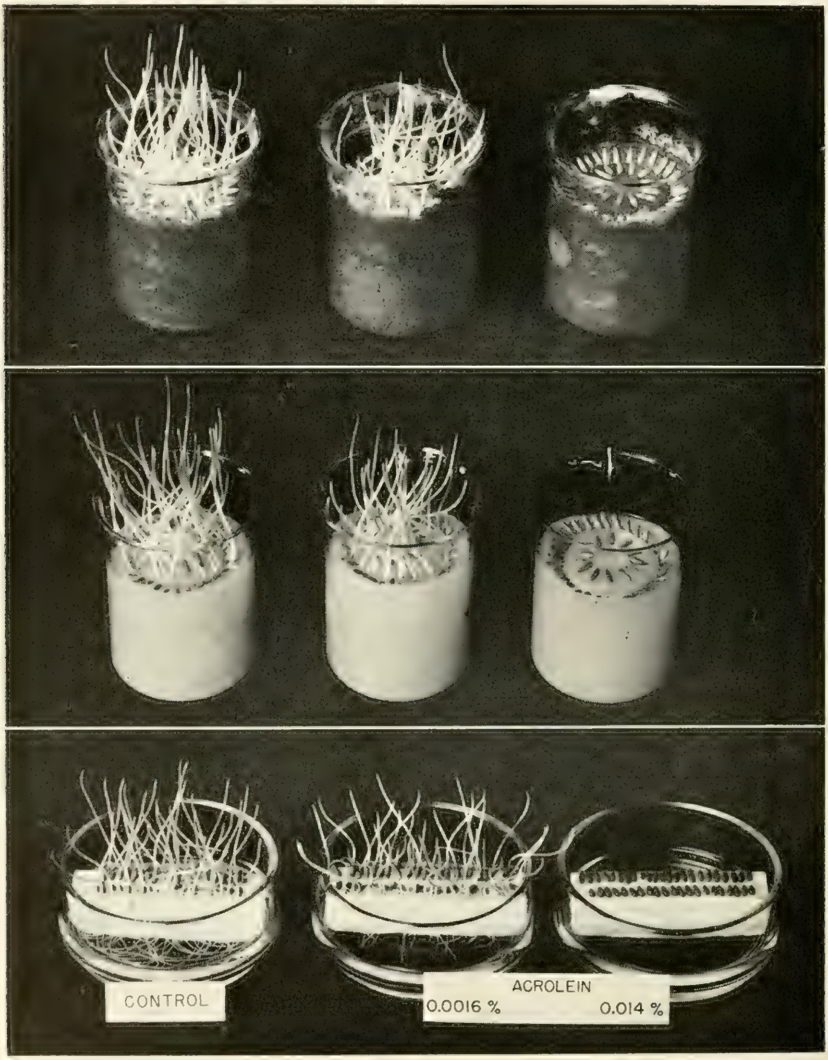
1. INHIBITORY EFFECT OF WOOD AS INFLUENCED BY DISTANCE FROM SEED

A, control; B, C, cultured in single jar in presence of wood. Seeds at right-hand end of C were closest, and those at left-hand end of B were farthest from the wood. Photographed 4 days after planting.



2. INHIBITION BY HYDROGEN PEROXIDE VAPOR

A, control; B, cultured in jar containing dish of 20-percent H_2O_2 solution; C, cultured in jar containing dish of 50-percent H_2O_2 solution; D, cultured in jar containing dish of 90-percent H_2O_2 solution. Note greater inhibition and bleaching of seeds at right-hand ends of wicks, which were closest to H_2O_2 solutions. Photographed 4 days after planting.



INHIBITION BY VAPOR OF ACROLEIN

Seeds planted on garden loam (upper row), 1.5-percent agar-water gel (middle row), and filter-paper-wrapped porous silica wicks (lower row). At the higher concentration (0.014 percent by volume of air) the seeds were killed and did not recover on subsequent exposure to pure air. Photographed 4 days after planting.

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INTRODUCTION

The genus *Brevoortia,* as herein understood, contains seven American species, five of which occur on the Atlantic coast of North America and two on the Atlantic coast of South America. The genus has been reported, also, from the Atlantic coast of Africa. Indeed, Fowler (1936, p. 174) identified the African representative with *B. tyrannus* of the Atlantic coast of the United States. This record certainly is in need of verification. However, no specimens are available for study, and nothing new on the African menhaden can be added at this time.

The genus, in respect to the American species, was last reviewed by G. Brown Goode in 1878, who did such excellent work that most of his determinations still stand. I have elevated his *B. tyrannus* var. *brevicaudata* to full specific rank for reasons stated in the account of that species. I also have recognized *B. aurea* (Agassiz) as a separate and distinct species which Goode regarded as a geographical variant of *B. tyrannus*. Furthermore, I have recognized two species among the specimens identified and described, in part, by Goode as *B. patronus.* One of these apparently is new, and is named and described in these pages.

Brevoortia is not known from the tropical shores of America nor from the West Indies. In North America it ranges from Nova Scotia to the mouth of the Rio Grande, being missing, however, in southern Florida. In South America the genus is known from Bahia, Brazil, to Bahia Blanca, Argentina.

The menhaden fishery.—The success of the menhaden fishery on the Atlantic coast of the United States, and to a lesser extent on the Gulf coast of the United States, affects the economic status of the people of those areas profoundly, as many depend almost wholly on this fishery for a livelihood. This, like other marine fisheries, fluctuates greatly. Periods of great abundance sometimes are followed by several lean years. However, it does not follow that when a small catch is made in North Carolina, for example, New Jersey also will have a small catch the same year. Indeed, the reverse may be true. The catch in the United States for certain years has exceeded 700,000,000 pounds, valued in recent years at about $11,000,000. A very small part of the catch is utilized as food for man, the bulk of it being used in the manufacture of oil, fish meal, and fish scrap. No fishery for *Brevoortia* seems to have been developed in South America, though the fish have been reported as abundant, at least at times, in southern Brazil and in Uruguay.

An explanation.—To avoid confusion, the following explanations as to how the enumerations and proportions used in the descriptions were obtained are offered. The number of fin rays includes both simple and divided rays, and the number of scales is based on the oblique rows that cross the middle of the side between the margin of the opercle and the base of the caudal. It is highly important for conformity with enumerations in the descriptions that the rows are counted at the middle of the side, as in some species the scales become much smaller dorsally and larger ventrally. This enumeration can be made with a considerable degree of accuracy in the species with large scales, at least, if the specimens are held at the proper angle to sight along the rows, magnification generally being unnecessary. The vertical rows usually are more distinct than the oblique ones on the trunk, but become so indistinct on the tail that their enumeration is not practical. The number of modified scales on the back, in front of the dorsal, includes only those that have a free lateral edge. As these scales are not fully developed until a fairly large size is attained it is advisable to use adult fish only for this enumeration, as explained subsequently. The serrations and pectinations of the scales are flexible (not spiny) in *Brevoortia,* and they are of unequal length in the different species (see fig. 8) ; therefore they are often useful in determining species. It is necessary, however, to compare scales from specimens of about equal size, as the pectinations increase in length with age. It is necessary, furthermore, to compare scales from the same part of the body. The scales illustrated in figure 8, for example, were all taken from the middle of the side below the anterior rays of the dorsal.

An attempt was made to count the abdominal and caudal vertebrae separately. However, so much difficulty was met that the separation was abandoned and only the total number of vertebrae is given in the descriptions.

The length of the head was measured from the rim of the snout to the most distant part of the bony margin of the opercle, and its depth is the distance between the slight groove at the occiput and the keel of the first ventral scute. Although the last-mentioned measurement is not an exactly vertical one, it does constitute one between two solid points, and therefore a fairly accurate one. The mandible was measured to its posterior extremity. The length of the pectoral and ventral fins in each instance is the distance between the base of the first ray and the tip of the fin; the lower lobe of the caudal was measured from the middle of the caudal base; and the axillary appendage of the pectoral was measured from the base of the upper ray of the pectoral. The other measurements were made in the usual way, or if there is any deviation, it is so stated in the descriptions.

Acknowledgments.—The writer is indebted to many persons for specimens, data, and other help received. He is particularly grateful to Gordon Gunter, of the University of Texas, for furnishing a very fine series of specimens of the new species herein named for him. The kindness of William C. Schroeder, of the Museum of Comparative Zoology, and of William C. Neville and John C. Pearson, of the United States Fish and Wildlife Service, in furnishing specimens is deeply appreciated. I am indebted, furthermore, to Mr. Schroeder for the loan of specimens from South America, for without them it would not have been possible to give adequate descriptions of those hitherto obscure species. I am grateful, of course, to those officers of the United States National Museum who have provided laboratory space and the use of the specimens in the National Museum collections.

While most of the data used were compiled by me, during the course of about 30 years, I have included some unpublished enumerations and proportions by the late William C. Welsh, and others by Dr. A. B. Hardcastle, now of the United States Bureau of Animal Industry. I am grateful to Dr. Hardcastle for the use of his unpublished manuscript on *B. tyrannus* based on a study of specimens from Beaufort, N. C. The illustrations were prepared by Mrs. Ann S. Green, biological aid with the United States Fish and Wildlife Service, who also gave valuable assistance in compiling the data and in preparing the bibliography.

Origin and necessity of the review.—This review is primarily a "by-product" of the study of the genus in connection with the preparation of accounts of the species of Clupeidae for the forthcoming general publication on the "Fishes of the Western North Atlantic," by the Sears Foundation, Yale University. As that general work is intended for the use of the general biologist and intelligent layman, taxonomic reviews are out of place. Therefore, this somewhat technical treatise is offered as preliminary to the more general treatment given the North American species in the general work mentioned. This preliminary study of the American species was necessary because some of the species were imperfectly known. The South American species, indeed, had been identified with *B. tyrannus,* as only subspecifically, or as specifically distinct from it. Under this confusion it was not even possible to state the range of the commonest species of North America.

Genus BREVOORTIA Gill

The Menhaden

Brevoortia Gill, 1861, p. 37 (genotype by designation, *Brevoortia menhaden* Gill = *B. tyrannus* (Latrobe)).

Description.—Body oblong, compressed, median line of chest and abdomen with a sharp edge, bearing bony scutes; mouth large, the maxillary extending to or beyond middle of eye; upper jaw with a distinct median notch; lower jaw included in the upper one, not projecting, its upper margin (within the mouth) nearly straight; teeth wanting in adults; cheek (bone below eye) deeper than long; lower limb of first gill arch with an obtuse angle; gill rakers long, slender, numerous, increasing in number with age, those on upper limb of first arch extending downward and over those on the upper part of the lower limb; scales adherent, exposed parts much deeper than long, the margins serrate or pectinate in adults; a series of modified scales next to median line of back in front of dorsal fin; vertebrae about 42 to 50; dorsal with 17 to 22 rays—the last one not produced—origin of fin about equidistant from margin of snout and base of caudal; anal with 17 to 25 rays; ventral fins small, with 7 rays; intestine very long; peritoneum black.

Some changes that occur with age and growth.—Young, under about 70 mm. in total length, have minute teeth on the margin of the maxillary (verified in all the species except *aurea* and *smithi*), which soon disappear with age and growth. In such young the gill rakers are short and those on the upper limb of the first arch do not yet extend downward over those on the upper part of the lower limb. The two series of modified scales, one on each side of the median line of the back in front of the dorsal fin, often do not become fully developed until the young reach a total length of 100 to 125 mm. or more, and the other scales have merely somewhat indented edges in the young, the serrae or pectinations developing with age and growth, being longer in large specimens than in half-grown ones. This development makes it necessary to compare specimens of the different species of nearly equal size as already indicated, to show actual differences in this respect. It is important, also, to compare scales from the same part of the body, as the serrations are not uniformly developed on all parts. In general, the serrae are larger on the scales from the back than those from the lower part of the side. The illustrations (fig. 8) given are based on scales of adults taken from the middle of the side below the anterior rays of the dorsal.

Relationship of the species.—The seven species of American menhaden roughly fall into two groups on the basis of scales. One group—*tyrannus, brevicaudata, patronus, pectinata,* and *aurea*—has moderately large scales, which are arranged in fairly regular series on the sides of the body, and the other group—*smithi* and *gunteri*—has smaller and more irregularly placed scales. The species may also be divided into two groups on the shape of the ventral fins, *tyrannus, brevicaudata,* and *patronus* having rounded fins in which the innermost ray is not much shorter than the outermost one, while *smithi, gunteri, pectinata,* and *aurea* have fins with nearly straight (somewhat convex in *aurea*) oblique margins in which the innermost ray is much shorter than the outermost one (see fig. 9), giving the fin a pointed appearance when folded. Also the South American species may be separated from the North American ones by the smaller reduction in the size of the scales on the back and on the base of the caudal in comparison with the scales on the middle of the side.

The North American species fall into two closely related pairs, namely, *tyrannus* from the Atlantic and *patronus* from the Gulf, and *smithi* from the Atlantic and *gunteri* from the Gulf, and one odd one, *bevicaudata,* from Noank, Conn., related to *tyrannus.* The close relationship between the species of each pair named is not confined to *Brevoortia,* as a similar relationship exists between the shad, *Alosa sapidissima,* of the Atlantic, and *A. alabamae* of the Gulf, and also between *Pomolobus mediocris* of the Atlantic and *P. chrysochloris* of the Gulf and Mississippi Valley. Nor is such a relationship limited to the family Clupeidae, as two similarly closely related pairs are known to exist in the family Sciaenidae, namely, *Cynoscian regalis* of the Atlantic and *C. arenarius* of the Gulf (Ginsburg, 1929, p. 83), and the other pair occurs in the genus *Menticirrhus* (also discovered by Ginsburg, unpublished).

In each pair of the fishes named, the range very probably once was continuous, but became discontinuous when the last passageway for fishes across the Florida peninsula became closed. None of the fish named occur in southern Florida, indicating that suitable conditions for their welfare do not exist there. Hence, the separation of the Atlantic and Gulf representatives is complete. Under this separation, and under the influence of a different environment, the fishes named seem to have become sufficiently differentiated to constitute distinct species.

KEY TO THE SPECIES

a. Scales relatively large, fairly regularly placed, 35 to 56 oblique series crossing middle of side; body rather elongate, its greatest depth 30 to 40 percent of the standard length.

b. Scales on back and at base of caudal much smaller than those along middle of side; ventral fin with a definitely convex margin; the innermost ray more than two-thirds length of the outermost one, the fin not pointed when folded; upper part of opercle with prominent radiating striae; shoulder spot followed by a variable number of smaller dark spots in adults.

c. Ventral outline of body anteriorly moderately convex; usually only about half the greatest depth below a straight line extending through lower margin of eye to middle of base of caudal; sheath of scales at base of dorsal fin low, composed for the most part of a single row of scales, covering only the basal third of the longest rays when standing erect; pectoral fin rather short, falling far short of reaching base of ventral fin, 3 to 7 vertical series of scales between its tip and base of ventral, the fin with 16 to 18 (rarely 15) rays.

d. Maxillary long, reaching well beyond vertical from posterior margin of pupil, 13 to 16 percent of standard length; mandible long, 16 to 19 percent; pectoral fin moderately long, failing to reach base of ventral fin by less than diameter of eye, 3 or 4 vertical rows of scales between tip of pectoral and base of ventral, its length 17 to 21 percent of standard length; caudal fin moderately long, the lower lobe about as long as head, 25 to 35.5 percent of standard length ....**tyrannus**, p. 7

dd. Maxillary shorter, reaching only to vertical from posterior margin of pupil, 12 to 13 percent of standard length; mandible short, 15.5 to 16 percent; pectoral fin short failing to reach base of ventral fin by a distance exceeding diameter of eye, 5 to 7 vertical series of scales between its tip and base of ventral, its length 15.5 to 16 percent of standard length; caudal fin very short, the lower lobe shorter than head, 22.5 to 25 percent of standard length ....**brevicaudata**, p. 10

cc. Ventral outline of body anteriorly strongly convex; much more than half the greatest depth below a straight line extending through lower margin of eye to middle of base of caudal; sheath of scales at base of dorsal fin much higher, composed for the most part of two rows of scales, covering basal two-thirds of shortest rays when standing erect; pectoral fin longer, often nearly reaching base of ventral fin, seldom more than 1 or 2 vertical series of scales between its tip and base of ventral, the fin with 14 to 17 (usually 15 or 16) rays; caudal fin long, the lower lobe often longer than head, 31 to 39 (usually 32 to 36.5) percent of standard length.......**patronus**, p. 13

bb. Scales on back and at base of caudal not much smaller than those along middle of side; ventral fin with a nearly straight to slightly convex oblique margin, the innermost ray not more than two-thirds length of the outermost one, the fin pointed when folded; upper part of opercle with feeble radiating striae if any; shoulder spot not followed by smaller dark spots.

e. Scales large, 35 to 46 oblique series crossing middle of side, 5 longitudinal rows on side of caudal peduncle; pectoral fin long, sometimes reaching base of ventral fin, occasionally falling short of this point by diameter of pupil, its length 17.5 to 21 percent of standard length, 0 to 3 vertical series of scales between its tip and base of ventral................................**pectinata**, p. 21

ee. Scales smaller, 48 to 56 oblique series crossing middle of side, 7 longitudinal rows on side of caudal peduncle; pectoral fin shorter, failing to reach base of ventral fin by a space varying from a half to a full diameter of eye, its length 16.7 to 18 percent of standard length, 3 to 6 vertical series of scales between its tip and base of ventral....................**aurea**, p. 25

aa. Scales quite small, irregularly placed, difficult to enumerate, about 60 to 75 oblique series crossing middle of side; body deep, its greatest depth 36 to 45.5 percent of standard length; upper part of opercle with feeble radiating striae or none; shoulder spot not followed by smaller dark spots.

f. Head small, its length 29 to 31.5 percent of standard length; maxillary reaching below middle of eye to posterior margin of pupil, 2.0 to 2.4 in head; pectoral fin short, generally failing to reach base of ventral fin by rather more than half diameter of eye, 5 to 8 vertical series of scales between its tip and base of ventral, its length 18.5 to 21 percent of standard length; total number of ventral scutes 30 to 32 (usually 30); vertebrae 45 to 47....................................**smithi**, p. 28

ff. Head larger, its length 31 to 35.5 (usually 32 to 34) percent of standard length; maxillary reaching to or a little beyond vertical from posterior margin of pupil, 1.8 to 2.2 in head; pectoral fin longer, generally failing to reach base of ventral fin by less than diameter of pupil, 2 to 4 vertical series of scales between its tip and base of ventral, its length 19 to 23.5 (usually 20 to 22) percent of standard length; total number of ventral scutes 27 to 30 (usually 28 or 29); vertebrae 42 to 44..................................**gunteri**, new species, p. 31

BREVOORTIA TYRANNUS (Latrobe)

Menhaden, Mossbunker, Bunker, Fatback, Shad, Pogy, Bugfish

Figure 1

Clupea tyrannus Latrobe, 1802, p. 77, pl. 1, Chesapeake Bay (name; drawing, without dorsal fin; no description; notes, which do not seem to apply to menhaden, but more probably to some species of *Pomolobus;* an isopod, *Olencira praegustator,* removed from the mouth of the fish, and described).

Clupea menhaden MITCHILL, 1815, p. 453, New York (original description; occurrence in New York).

Clupea neglecta RAFINESQUE, 1818, p. 206, Long Island, N. Y. (original description).

Alosa menhaden DE KAY, 1842, p. 259, pl. 21, fig. 60 (description; local names; economic importance; occurrence in New York).

Alosa sadina DE KAY (not of Mitchill), 1842, p. 263, pl. 40, fig. 129 (description; figure clearly shows *B. tyrannus*).

Clupea carolinensis GRONOW, 1854, p. 140, South Carolina (original description).

Brevoortia menhaden GILL, 1873, p. 811 (common names; range).

Brevoortia tyrannus GOODE, 1878a, p. 5 (a discussion establishing the validity of Latrobe's specific name, *tyrannus*); 1878b, p. 31 (description; compared with *"var. aurea,"* and with *"patronus"*; "varieties" *menhaden* and *aurea* recognized, and a new variety, *brevicaudata,* named and defined); 1879, p. 19 (a complete history of the American menhaden; species and varieties discussed; common names; industry fully described).—JORDAN AND EVERMANN, 1896, p. 433, and 1900, fig. 195 (description; range; synonymy).

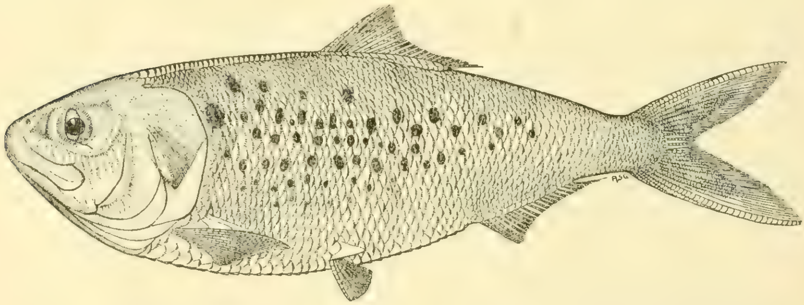

FIG. 1.—*Brevoortia tyrannus,* based on a specimen 320 mm. in total length, 247 mm. in standard length (U.S.N.M. No. 129809), from Chesapeake Bay at Kenwood Beach, Md.

Validity of the specific name tyrannus.—Although Latrobe did not describe the fish he named *Clupea tyrannus,* and even though the notes he gave probably apply to *Pomolobus pseudoharengus* (Wilson), his figure resembles the menhaden closely. This is true, notwithstanding the fact that it lacks a dorsal fin. The shape certainly is correct for the menhaden, and the dark shoulder spot, constantly present, is correctly indicated. The presence of the isopod, *Olencira praegustator,* in its mouth, which Latrobe did describe and figure, offers further proof that he was dealing with the menhaden, for according to Richardson's "Monograph on the Isopods of North America" (1905, p. 231) this crustacean is known to be parasitic only on the menhaden *Brevoortia,* which apparently still holds true. There seems to be no reason, then, to question the availability of the specific name *tyrannus* for this species, even though Latrobe offered no description.

Relationship.—*B. tyrannus* of the Atlantic is closely related to *B. patronus* of the Gulf of Mexico. The relationship is shown in a parallel comparison in the account of the last-mentioned species (p. 20).

Source of the data and their presentation.—The proportions and enumerations given in the following paragraph are mostly based on 100 or more specimens and some of them on 200 or more examples. In the range of proportions specimens less than 70 mm. in total length were excluded because they were considered juveniles. The material studied was collected at many places, from Massachusetts Bay (vicinity of Boston) to Mayport, Fla. The range in the percentages of the parts measured in the standard length is given first in each instance, and this is followed by the number of times these same parts are contained in the standard length or in the head, as the case may be, enclosed in parentheses.

Some proportions and enumerations.—Head 28 to 36 (2.75 to 3.5 in standard length), its depth 25 to 32 (3.1 to 4.0 in standard length); depth of body 30 to 39 (2.55 to 3.3. in standard length); base of anal 14 to 19 (5.25 to 7.1 in standard length); lower lobe of caudal 25 to 35 (2.85 to 4.0 in standard length); caudal peduncle, depth 8.5 to 11 (2.9 to 4.0 in head); eye, difficult to measure because of much adipose tissue, about 5.5 to 8.3 (about 4.4 to 6.2 in head); snout 5.5 to 9 (3.9 to 5.5 in head); interorbital (bone) 6.2 to 8.2 (4.2 to 5.3 in head); maxillary 13.5 to 16.5 (1.9 to 2.7 in head); mandible 16.5 to 20 (1.7 to 2.0 in head); pectoral 17 to 20 (1.6 to 1.9 in head); axillary appendage of pectoral variable, 8.0 to 15 (2.3 to 3.8 in head). Dorsal rays 17 to 22; anal rays 18 to 24; pectoral rays 16 to 18, rarely 15; scales in oblique series crossing middle of side 41 to 55; vertical series between tip of pectoral and base of ventral 3 or 4; modified scales in a series in front of dorsal 31 to 43; ventral scutes 30 to 35; gill rakers on lower limb of first arch increasing in number with age, about 60 in specimens 60 mm. long, about 100 in specimens 100 mm. long, about 140 in examples 200 to 250 mm. long, and 150 to 160 in large adults 330 to 360 mm. long; vertebrae 47 to 49, rarely 45, 46 or 50 (enumerated in 194 specimens).

Variation.—The range in many of the proportions and enumerations given in the preceding paragraphs is rather wide. This results in part from the many specimens used, and in part from the differences in examples from the various localities within the range of the species. The proportions also are affected by the large range in size of the specimens measured. Insufficient specimens even now are available for the definite determination of the races or populations that exist. For example, only four specimens from the entire Gulf of Maine are at hand, and none from South Carolina and Georgia. Furthermore, the material from North Carolina and Florida includes few large adults. Therefore, a definite analysis of the various races or populations must await the receipt of additional specimens for study. It can only be stated that the head tends to become larger toward the southern part of the range, as both its length and depth increase slightly in proportion to the standard length. Similarly, the maxillary, the mandible, the pectoral fin, and the caudal fin are proportionately rather longer in specimens from the southern part of the range than in those from the northern part. There is also a slight average reduction in the number of dorsal rays in southern specimens. The data do not show a decrease in the number of vertebrae in southern examples, which is so common an occurrence in fishes generally that it was expected.

It may be noted also that in general northern fish run larger in size, are fatter, and definitely yield more oil per fish than southern ones. Furthermore, spawning occurs during the summer northward, as at Woods Hole, Mass., whereas southward, as in the Chesapeake Bay area, and on the coast of North Carolina, it definitely occurs in late fall and winter. The evidence, then, indicates that each section of the coast has its own population or race. However, as already indicated, more data are required before the morphological differences can be shown accurately.

Range.—Nova Scotia to Florida. Taken commercially from Maine to Mayport, Fla. More or less reliably reported from as far south as off Cape Carnaveral and Mosquito Inlet, Fla. (Goode, 1879, p. 36). This species has been reported from the Gulf of Mexico and from South America by various authors. However, menhaden from the Gulf and from South America are recognized herein as distinct species. It has also been reported from West Africa, a record regarded by the writer as probably incorrect, which he cannot verify, however, as the necessary specimens are not at hand.

BREVOORTIA BREVICAUDATA Goode

FIGURE 2

Brevoortia tyrannus var. *brevicaudata* GOODE, 1878b, pp. 34 and 37, Noank, Conn. (descriptive notes; compared with "normal" *tyrannus* and with *aurea;* table of measurements and enumerations).

Brevoortia tyrannus brevicaudata GOODE, 1879, p. 22, Noank, Conn. (said to vary from "normal" type of *tyrannus* in having a shorter maxillary, a shorter mandible, lower anal, and shorter caudal).—JORDAN and EVERMANN, 1896, p. 434 (compared with *aurea,* after Goode).—JORDAN, EVERMANN, and CLARK, 1930, p. 44 (range; synonymy).

Study material.—G. Brown Goode (1878b) in his revision of the genus *Brevoortia,* reported certain specimens from Noank, Conn., as differing from the local "normal" *tyrannus* in several respects, and as closely related to *aurea,* a South American menhaden. He designated the Noank specimens a variety of *tyrannus,* naming it *brevicaudata* because of the very short caudal fin. I have examined eight

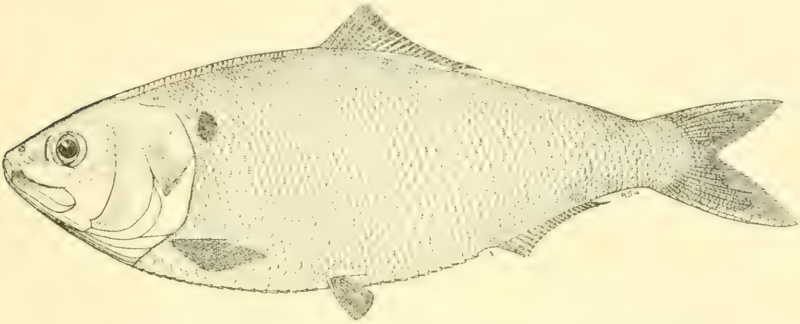

FIG. 2.—*Brevoortia brevicaudata,* based on the lectotype, a specimen 180 mm. in total length, 145 mm. in standard length (U.S.N.M. No. 129797), from Noank, Conn.

specimens from Noank, Conn. The same ones were studied, at least in part, by Goode, who gave in a table of measurements and enumerations the National Museum number 14846, which one of the two lots still bears. These specimens (U.S.N.M. Nos. 14044 and 14846), collected in 1874, are still the only ones of their kind in the collections (mostly in the National Museum) studied. It is indeed strange that no others like them have been noticed.

Relationship.—*B. brevicaudata* cannot be a geographical variant, as typical *tyrannus* also occur in the general vicinity of Noank, Conn. The specimens from Noank, in fact, differ in so many characters from *tyrannus,* some of which show no intergradation, that it becomes necessary to recognize them as representing a distinct species. The distinguishing characters of *brevicaudata* and *tyrannus* are shown in the parallel comparison that follows. To make the comparison a fair one specimens of about equal size and all from the general vicinity of Noank, Conn., were used. The differences would be even greater if specimens of *tyrannus* from the southern part of the range, as from Florida, were compared, as they have larger heads and longer fins than northern material.

A lectotype designated.—As Goode did not designate a type, I have selected a specimen (U.S.N.M. No. 129797) approximately 180 mm. (caudal imperfect) in total length and 145 mm. in standard length as lectotype. This specimen is from a lot quite certainly examined by Goode, as already stated.

Source of the data and their presentation.—The following list of proportions and enumerations are based on the eight specimens already listed, which vary from 165 to 180 mm. in total length, and from 126 to 147 mm. in standard length. The range in the percent of standard length of the parts measured is given first in each instance followed by the proportion based on the lectotype, and then the proportion in the standard length or in the head is enclosed in parentheses. The enumerations are given in the same order.

Some proportions and enumerations.—Head 29 to 30, 29 (3.3 to 3.85, 3.45 in standard length), its depth 26 to 27.5, 26 (3.6 to 3.84, 3.8); depth of body 35 to 38, 36 (2.6 to 2.85, 2.8); anal base 17.5 to 19, 17.5 (5.25 to 5.7, 5.7); lower lobe of caudal 22 to 25, 25 (4.0 to 4.4, 4.0); depth of caudal peduncle 9.6 to 10.5, 9.8 (2.8 to 3.0, 2.9 in head); eye 5.4 to 6, 5.4 (4.7 to 5.4, 5.25 in head); snout 6.4 to 7.3, 7.3 (3.9 to 4.6, 3.9 in head); interorbital (bone) 6.2 to 7.0, 7.0 (4.1 to 4.7, 4.1 in head); maxillary 12 to 13, 12 (2.2 to 2.4, 2.4 in head); mandible 15.5 to 16, 15.5 (1.8 to 1.9, 1.85 in head); pectoral fin 13.5 to 16, 14.5 (1.8 to 2.2, 2.0 in head); axillary appendage of pectoral 8.0 to 9.4, 8.9 (3.0 to 3.8, 3.2 in head). Dorsal rays 20 or 21, 21; anal rays 21 or 22, 21; pectoral rays 17; scales, oblique series crossing middle of side, 47 to 53, 48; vertical series between tip of pectoral and base of ventral 5 to 7, 6; modified scales in a series in front of dorsal fin 35 to 39, 39; ventral scutes 31 to 33, 33; gill rakers on lower limb of first arch 112 to 127, 124; vertebrae 48 (enumerated in 1 specimen).

The lectotype (fig. 2) has only the shoulder spot. However, one specimen with it has a rather definite row of smaller dark spots below and behind the shoulder spot, indicating that auxiliary spots, at least sometimes, are present in this species.

A parallel comparison of B. tyrannus *and* B. brevicaudata.—The principal differences between *tyrannus* and *brevicaudata* are shown in the following parallel comparison, wherein only specimens of about equal size from the same general vicinity were considered.

tyrannus	*brevicaudata*
Head moderately large, its length 30 to 33 percent, and its depth 27.5 to 31 percent of standard length.	Head small, its length 29 to 30 percent, and its depth 26 to 27.5 percent of standard length.
Maxillary long, reaching well beyond vertical from posterior margin of pupil, 13.5 to 16.5 percent of standard length.	Maxillary shorter, reaching vertical from posterior margin of pupil, 12 to 13 percent of standard length.
Mandible moderately long, 16.5 to 19 percent of standard length.	Mandible shorter, 15.5 to 16 percent of standard length.
Eye moderately large, 6.2 to 6.9 percent of standard length.	Eye small, 5.4 to 6.0 percent of standard length.
Origin of dorsal generally a little nearer base of caudal than margin of snout.	Origin of dorsal somewhat nearer margin of snout than base of caudal.
Pectoral fin moderately long, failing to reach base of ventral by less than diameter of eye, 3 or 4 vertical rows of scales between its tip and base of ventral, its length 19 to 20 percent of standard length, 1.6 to 1.75 in head.	Pectoral fin very short, failing to reach base of ventral by a distance greater than diameter of eye, 5 to 7 vertical rows of scales between its tip and base of ventral, its length 13.5 to 16 percent of standard length, 1.8 to 2.2 in head.
Axillary process of pectoral variable in length, generally about two-thirds length of fin, 10 to 11.5 percent of standard length.	Axillary process of pectoral very short and broad, only about half the length of fin, 8.0 to 9.4 percent of standard length.
Caudal fin moderately long, the lower lobe about as long as head, 29 to 34 percent of standard length.	Caudal fin shorter, the lower lobe much shorter than head, 22 to 25 percent of standard length.
Dorsal fin moderately elevated anteriorly, the longest rays greatly exceeding the depth of the caudal peduncle.	Dorsal fin little elevated anteriorly, the longest rays about equal to the depth of the caudal peduncle.

Range.—Known only from Noank, Conn.

BREVOORTIA PATRONUS Goode

Large-scale Gulf Menhaden

Figure 3

Brevoortia patronus Goode, 1878b, p. 39, Brazos Santiago, Tex. (description based on Brazos Santiago specimens (U.S.N.M. No. 892); diagnosis and table of measurements based in part on specimens from the "Mouth of the Rio Grande" (U.S.N.M. No. 891), which are *B. gunteri* n. sp.); 1879, p. 26, pl. 5 (diagnosis and description copied from original account); 1884, p. 575, pl. 206 (common names; movements; parasites; reproduction; food).—Jordan, Evermann, and Clark, 1930, p. 44 (range; synonymy).

Brevoortia tyrannus patronus Jordan and Evermann, 1896, p. 434 (compared with Atlantic menhaden; range and abundance; synonymy).—Evermann and KENDALL, 1892, p. 105, pl. 21, Galveston, Tex. (differences between Atlantic and Gulf menhaden regarded as slight).

Brevoortia tyrannus GUNTER (not of Latrobe), 1945, p. 29 (occurrence on coast of Texas; habitat).

Type material.—This species was described in Goode's revision of this genus (1878b). The account was based on specimens from Brazos Santiago, Tex., and on specimens from the "Mouth of the Rio Grande." That Goode confused two species is evident from a critical reading of his published data and the examination of his type material. The latter now consists of four lots of specimens. The lot (U.S.N.M. No. 892), containing two specimens, each 98 mm. in standard length (caudal fins broken), from Brazos Santiago, Tex., was designated

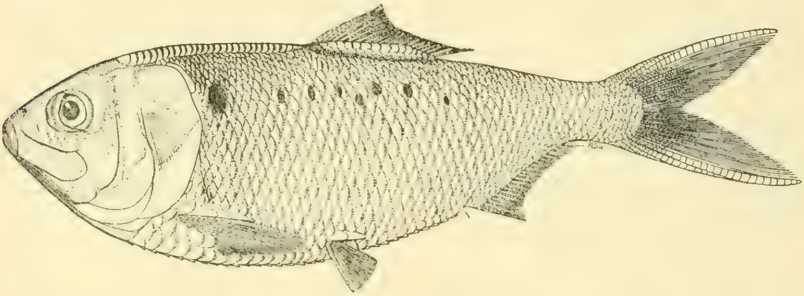

FIG. 3.—*Brevoortia patronus,* based on a specimen 215 mm. in total length, 164 mm. in standard length (U.S.N.M. No. 129810), taken off Galveston, Tex.

"types" either by Goode or someone else. This designation seems entirely proper, as Goode stated that his description was based on specimens from Brazos Santiago, and in it he used only proportions and enumerations based on these specimens as given in his "Table of Measurements." Therefore, these types definitely represent *B. patronus,* as herein understood. There is at hand a second lot of five small specimens (U.S.N.M. No. 893) also from Brazos Santiago, which Goode must have seen, even though he did not specifically mention them. These specimens, nevertheless, were recorded as *"Brevoortia patronus"* in the register of the Museum along with the types. This lot now consists of one specimen of *B. patronus,* and four of *B. gunteri* n. sp., as herein understood.

Another lot of nine small specimens (U.S.N.M. No. 891) collected in the mouth of the Rio Grande, designated as paratypes of *B. patronus,* also was examined by Goode, as he gave proportions and enumerations for three of these specimens in his tables. These specimens

TABLE 1.—*Number of scales in species of* Brevoortia

Number of oblique series crossing middle of side

Species	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
B. tyrannus	..	..	..	..	..	..	..	1	2	3	8	12	15	16	16	14	19	6	12	6	3	2
B. brevicaudata	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1	..	..	1	..	2	1	..
B. patronus	1	..	4	2	11	10	19	14	13	9	4	12	8	3	2	3	1	..	.	.	.	..
B. pectinata	..	1	3	..	..	1	4	3	7	4	2	2	2	..	..	..	..	..	..	..	..	..
B. aurea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	3	6	1	1	..	1	1
B. smithi	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
B. gunteri	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Species	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
B. tyrannus	..	..	..	..	..	.			..	.	..	..	.								
B. brevicaudata	..	..	..	..	..	.	..		..												
B. patronus	..	..	.	..	..	.				.	..	.									
B. pectinata	..	..	..	..	..	.	.		.	.											
B. aurea	..	..	..	..	..	..	..	..	..	..	.	.		.					..		
B. smithi	..	..	..	..	3	1	1	1	2	1	3	1	..	..	1	2	1	..		.	
B. gunteri	..	..	1	2	4	2	..	2	4	7	3	1	5	4	7	1	2	1	3	1	2

Number of modified scales in a series on back in front of dorsal fin

Species	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
B. tyrannus	..	..	..	..	..	..	..	4	7	16	29	38	24	29	21	13	6	3	4	1	..	..	..	..
B. brevicaudata	..	..	..	..	..	..	..	..	..	..	..	1	1	2	..	1	..	..	..	.	.	..	..	
B. patronus	2	11	13	10	18	15	17	11	4	1		.	.	.	.	..								.
B. pectinata	..	..	..	..	..	..	..	..	2	..	1	4	3	..	1	3	4	2	..	1	1	..	1	1
B. aurea	..	..	..	..	..	..	..	..	..	..	..	1	..	..	2	4	3	..	1	2	..	..	1	..
B. smithi	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	1	6	3	1	2	2		
B. gunteri	..	..	..	..	..	..	..	..	..	..	..	1	3	4	6	2	8	3	8	2	3	2	..	

Species	34	35	36	37	38	39	40	41	42	4	73	74	75	76
B. tyrannus	..	..	..	..	..	..	..	1	2		..	..	..	..
B. brevicaudata	..	..	..	..	..	..	..	..	..	.	..	..	..	..
B. patronus	1	..	4	2	11	10	19	14	13		..	..	..	..
B. pectinata	..	1	3	..	..	1	4	3	7		..	..	..	..
B. aurea	..	..	..	..	..	..	..	..	..	.	..	..	..	..
B. smithi	..	..	..	..	..	..	..	..	..	.1	..	..	..	..
B. gunteri	..	..	..	..	..	..	..	..	..	.2	1	3	1	2

	24	25	26	27	28	29	30	31	32	3
B. tyrannus	..	..	..	..	..	..	..	4	7	1
B. brevicaudata	..	..	..	..	..	..	..	..	..	.
B. patronus	2	11	13	10	18	15	17	11	4	
B. pectinata	..	..	..	..	..	..	..	..	2	.
B. aurea	..	..	..	..	..	..	..	..	..	.
B. smithi	..	..	..	..	..	..	..	..	..	.
B. gunteri	..	..	..	..	..	..	..	..	..	.

are all of the small-scale species, herein designated *B. gunteri* n. sp. It is evident that Goode included the specimens with the fine scales in his "Diagnosis" of *B. patronus,* because he gave a range of 50 to 70 scales in the "longitudinal rows." This range includes enumerations contained in his tables, based in part on the large-scale species, *B. patronus,* from Brazos Santiago, and in part on the small-scale form, *B. gunteri,* from the mouth of the Rio Grande. Finally, Goode gave proportions and enumerations for three small specimens from a lot now consisting of two specimens (U.S.N.M. No. 5864), for which the place of collection is unknown. The two specimens from this lot at hand are *B. patronus,* while the missing one very probably was *B. gunteri,* as Goode enumerated "about 70" scales in the "lateral line." Goode's type material has now been separated and the two species represented have been registered accordingly in the catalog of the National Museum.

Relationship.—*B. patronus* is closely related to *B. tyrannus,* and generally has been considered as only subspecifically distinct from it, or identical with it, by authors. However, it is evident from a critical study that the two differ in many respects, and to such a degree that they apparently should be treated as distinct species. The principal differences are shown in the parallel comparison presented herewith. The tables (Nos. 1 to 7) show deviations in many ways. Even though there is overlapping in all the proportions and enumerations given, it is evident, at once, that the modes often differ widely.

Although the range of the two species is now discontinuous, it was no doubt once continuous. Menhaden are not known to occur on the shores of southern Florida, "Indian River" on the Atlantic and Tampa on the Gulf apparently being the limits of the range southward, respectively, of *tyrannus* and *patronus.*[1] The differences that now exist between the two are exactly what one would expect after a long separation under the influence of a different environment. It is true, also, and in keeping with expectation, that the large-headed, deep-bodied,

[1] The writer is aware that Silas Stearns, in Goode (1884, p. 575), implied, at least, that *B. patronus* occurred at Key West, Fla. However, Isaac Ginsburg and I resided at Key West for 1½ to 3 years, collected there rather extensively, but failed to find menhaden. It seems improbable, therefore, that *Brevoortia* occurs there. *Harengula* is common at Key West, and it may be that Stearns confused this genus with *Brevoortia.* Neither did Dr. Charles M. Breder, Jr., of the American Museum of Natural History see any at Palmetto Key, Fla., for he stated in a letter in reply to my inquiry, "In the five years that we spent at Palmetto Key I never saw any menhaden, nor were any taken to the best of my knowledge by others working there." No specimens from farther south than Appalachicola, Fla., are at hand, though it was reported from Tampa by Henshall (1894, p. 211).

TABLE 2.—*Total number of vertebrae and ventral scutes in species of* Brevoortia

Species	Vertebrae									Ventral scutes										
	42	43	44	45	46	47	48	49	50	27	28	29	30	31	32	33	34	35	36	37
B. tyrannus	..	..	..	1	2	26	118	45	2	..	..	1	8	32	79	80	35	8	3	..
B. brevicaudata	..	..	..	..	..	..	1	..	..	..	..	..	..	1	..	4	..	..	..	..
B. patronus	3	3	2	22	58	24	5	..	..	..	12	39	63	29	8	..	..	..	..	..
B. pectinata	..	..	..	2	2	2	..	..	..	..	..	6	12	12	3	..	..	..	..	..
B. aurea	..	..	..	1	1	..	..	..	..	..	..	..	4	5	1	2	..	..	..	..
B. smithi	..	..	..	3	9	1	..	..	..	..	..	..	2	11	5	..	..	..	..	..
B. gunteri	1	12	9	..	..	..	..	..	..	1	15	27	4	..	..	..	..	..	..	..

TABLE 3.—*Number of dorsal, anal, and pectoral rays in species of* Brevoortia

Species	Dorsal rays						Anal rays									Pectoral rays					
	17	18	19	20	21	22	17	18	19	20	21	22	23	24	25	13	14	15	16	17	18
B. tyrannus	3	19	79	89	35	1	1	2	8	44	87	44	21	2	..	..	..	7	58	123	25
B. brevicaudata	..	..	..	1	4	..	..	..	..	..	3	5	..	..	..	..	..	..	..	5	..
B. patronus	1	14	39	34	3	..	..	..	..	15	35	36	13	..	..	..	8	41	47	14	..
B. pectinata	3	15	15	1	..	..	..	..	2	11	13	8	..	..	..	2	..	13	16	4	..
B. aurea	..	6	8	..	..	..	..	..	1	2	5	5	1	1	..	..	2	7	4	..	..
B. smithi	..	6	10	1	..	..	..	..	..	..	..	5	11	1	..	..	..	4	10	3	..
B. gunteri	5	25	15	7	..	..	..	..	..	2	4	9	18	13	4	..	1	21	19	..	..

TABLE 4.—*Length and depth of head expressed in percent of standard length in species of* Brevoortia

Species	Length of head											Depth of head												
	28	29	30	31	32	33	34	35	36	37	38	25	26	27	28	29	30	31	32	33	34	35	36	37
B. tyrannus	2	4	9	36	54	51	36	8	1	..	..	3	13	39	53	41	26	12	2	..	..	..	..	..
B. brevicaudata	..	4	4	..	..	..	..	..	..	..	..	..	1	3	1	..	..	..	..	..	..	..	..	..
B. patronus	..	..	..	10	39	84	82	40	9	8	1	..	..	..	..	2	9	36	34	29	29	24	6	2
B. pectinata	..	..	2	4	8	4	..	..	..	..	..	..	..	..	3	8	6	5	1	..	..	..	..	..
B. aurea	..	3	1	2	6	4	1	..	..	..	..	..	1	3	2	3	6	..	..	..	..	..	..	..
B. smithi	..	2	3	8	4	..	..	..	..	..	..	..	..	1	4	6	1	2	..	..	..	..	..	..
B. gunteri	..	..	..	1	11	24	9	4	1	..	..	..	..	..	..	2	7	17	14	3	5	2	1	..

TABLE 5.—*Greatest depth of body expressed in percent of standard length in species of* Brevoortia

Species	Greatest depth of body															
	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
B. tyrannus	5	7	16	38	45	43	34	29	11	4	..	..	..	..	..	..
B. brevicaudata	..	..	..	..	..	1	2	2	3	..	..	..	..	..	..	..
B. patronus	..	..	..	2	7	16	17	36	36	29	38	30	24	7	3	3
B. pectinata	..	..	..	..	2	2	3	3	10	2	3	4	2	..	..	..
B. aurea	..	..	..	..	1	1	3	7	1	1	..	..	..	..	..	..
B. smithi	..	..	..	..	..	..	2	2	5	5	1	1	1	1	..	..
B. gunteri	..	..	..	..	..	..	..	2	10	13	10	8	3	3	2	1

TABLE 6.—*Maxillary and mandible expressed in percent of standard length in species of* Brevoortia

	Maxillary												Mandible											
Species	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5
B. tyrannus	..	..	..	8	19	37	42	20	14	5	..	..	..	..	..	6	10	29	27	20	7	4	1	1
B. brevicaudata	3	1	5	..	..	..	..	..	..	..	..	..	..	4	3	..	..	..	..	..	..	..	..	..
B. patronus	..	..	..	..	3	6	34	50	33	6	5	2	..	..	..	2	5	8	14	14	19	6	4	..
B. pectinata	..	..	..	3	3	8	3	1	2	..	..	..	3	1	4	2	3	4	6	1	..	..	..	..
B. aurea	..	1	2	1	4	5	1	1	..	..	..	..	..	1	..	2	2	1	4	1	..	..	..	..
B. smithi	..	..	2	4	10	3	1	..	..	..	..	..	..	..	..	3	5	6	3	1	..	..	..	..
B. gunteri	..	..	..	..	..	2	3	8	13	17	3	1	..	..	..	..	..	1	1	7	6	3	5	1

TABLE 7.—*Lower lobe of caudal fin and pectoral fin expressed in percent of standard length in species of* Brevoortia

	Lower lobe of caudal fin																		Pectoral fin										
Species	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	13	14	15	16	17	18	19	20	21	22	23
B. tyrannus	..	..	..	7	21	28	25	25	41	34	14	10	6	2	..	..	..	..	..	..	..	..	4	32	54	38	..	..	..
B. brevicaudata	1	2	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1	3	1	..	..	..	..	..	..	..
B. patronus	..	..	..	..	..	..	..	..	..	2	9	13	13	10	12	5	3	2	..	..	..	..	..	..	7	19	35	20	5
B. pectinata	..	..	..	..	..	..	..	..	..	..	..	2	1	4	4	1	..	..	..	..	..	..	..	4	9	5	3	..	..
B. aurea	..	..	..	..	..	..	..	..	..	2	..	1	5	1	..	..	..	..	..	..	..	..	9	4	..	..	..	..	..
B. smithi	..	..	..	..	..	..	..	..	..	..	2	3	3	..	1	1	..	..	..	..	..	..	..	3	6	7	2	..	..
B. gunteri	..	..	..	..	..	..	..	..	..	1	4	3	8	7	6	4	4	1	..	..	..	..	..	..	7	14	19	10	4

and long-finned examples from the Gulf are nearest to specimens of the Atlantic menhaden that occur on the opposite coast of Florida, which have larger heads, rather deeper bodies, and longer fins than specimens of *tyrannus* from northern localities.

Source of the data and their presentation.—The following list of proportions and enumerations, unless otherwise stated, are based on about 100 specimens, and some of them on many more. The examples used in determining the proportions range from about 60 to 265 mm. in total length and 45 to 207 mm. in standard length. These examples were collected at many places along the coast of the Gulf from Appalachicola, Fla., to Brazos Santiago, Tex., and they include the type specimens (U.S.N.M. No. 892) from the last-mentioned locality. The range in the percentage of standard length of the different parts measured is given first in each instance, followed by those based on the two "types," and then the proportion in the standard length or in the head is enclosed in parentheses. The enumerations are given in the same order.

Some proportions and enumerations.—Head 31 to 38, 37 and 37 (2.6 to 3.2, 2.7 and 2.7 in standard length), its depth 29 to 37, 33.5 and 35.5 (2.7 to 3.4, 2.8 and 2.95 in standard length); depth of body 33 to 45, 42 and 42 (2.2 to 3.0, 2.4 and 2.4 in standard length); anal base 17 to 21, 18.5 and 19.5 (4.75 to 5.9, 5.2 and 5.4 in standard length); lower lobe of caudal 31 to 39, broken (2.55 to 3.2 in standard length); caudal peduncle, depth 8.0 to 12, 10.2 and 10.2 (2.6 to 3.9, 3.6 and 3.65 in head); eye 7.0 to 9.2, 8.5 and 8.5 (3.7 to 5.0, 4.35 and 4.4 in head); snout 6.0 to 9.0, 7.5 and 8.5 (3.9 to 5.0, 4.3 and 5.0 in head); interorbital (bone) 6.5 to 8.0, 7.8 and 8.0 (4.1 to 5.0, 4.5 and 4.7 in head); maxillary 14 to 17.5, 17 and 17 (2.0 to 2.4, 2.1 and 2.1 in head); mandible 16.5 to 20, 18.5 and 20 (1.75 to 1.9, 1.8 and 1.9 in head); pectoral 19 to 23, 19.5 and 21.5 (1.5 to 1.9, 1.75 and 1.9 in head); axillary appendage of pectoral 8.5 to 13, 9.5 and 10.5 (2.5 to 4.0, 3.4 and 3.8 in head). Dorsal rays 17 to 21, 19 and 20; anal rays 20 to 23, 22 and 23; ventral rays 7; pectoral rays 14 to 17, 15 and 16; scales, oblique series crossing middle of side, 36 to 50, 47 and 49; vertical series of scales between tip of pectoral and base of ventral 0 to 3, 1 and 2; modified scales in a series in front of dorsal 24 to 33, 30 and 31; ventral scutes 28 to 32, 29 and 30; gill rakers on lower limb of first arch 40 to 50 in specimens about 25 to 40 mm. in total length, 80 to 85 in examples 45 to 60 mm. long, 125 to 130 in specimens 100 to 130 mm., and 135 to 150 in fish 200 mm. and upward in total length; vertebrae 42 to 48, usually 45 to 47, not counted in types (enumerated in 117 specimens).

A parallel comparison of B. tyrannus *and* B. patronus.—The principal differences between *tyrannus* and *patronus* are shown in the following parallel comparison.

tyrannus	*patronus*
Body moderately deep, rather robust, the ventral and dorsal outlines more or less evenly convex; usually only half of greatest depth below a straight line extending through lower margin of eye to middle of base of caudal; greatest depth generally over tip of pectoral fin, about two diameters of eye behind margin of opercle, 30 to 40, usually 32 to 37 percent of standard length, average in 232 specimens 34.2 percent.	Body usually deeper, more strongly compressed, the ventral outline much more strongly convex than the dorsal; notably more than half the greatest depth below a straight line extending through lower margin of eye to middle of base of caudal; greatest depth at or near beginning of posterior third of pectoral fin, only about an eye's diameter behind margin of opercle, 33 to 45, usually 35 to 42 percent of standard length, average in 248 specimens 38.8 percent.
Head moderately small, somewhat pointed, its length 28 to 36, usually 31 to 34 percent of standard length, average in 211 specimens 32.2 percent; its depth 25 to 32, usually 26 to 30 percent of standard length, average in 203 specimens 27.8 percent.	Head generally larger, blunter, its length 31 to 38, usually 32 to 34.5 percent of standard length, average in 274 specimens 33.6 percent; its depth 29 to 37, usually 31 to 36 percent of standard length, average in 158 specimens 33.5 percent.
Scaly sheath at base of dorsal composed for the most part of a single row of scales, not extending above basal third of the shortest rays, and not completely covering the fin if deflexed.	Scaly sheath at base of dorsal notably higher, composed for the most part of two rows of scales, covering basal two-thirds of shortest rays, and covering the fin, except for the rays extending backward beyond the sheath if deflexed.
Scales moderately large, 41 to 55, most frequently 45 to 52, average 48.2 in 135 specimens, if oblique series crossing middle of side are counted.	Scales somewhat larger, 36 to 50, most frequently 38 to 46, average 41.7 in 116 specimens, if counted as in *tyrannus*.
Modified scales on back in front of dorsal fin rather numerous, with long hairlike pectinations in large examples 31 to 43, most frequently 33 to 39, average 36 in 195 specimens.	Modified scales on back in front of dorsal fin generally fewer, with shorter pectinations in examples of equal size, 24 to 33, most frequently 25 to 31, average 28 in 103 specimens.
Caudal fin moderately short, the lower lobe about as long as head, 25 to 35, usually 26 to 33 percent of standard length, average 29.4 percent in 214 specimens.	Caudal fin rather longer, the lower lobe often longer than head, 31 to 39, usually 32 to 36.5 percent of standard length, average 34.5 percent in 69 specimens.

tyrannus	*patronus*
Pectoral fin rather short, not reaching base of ventral fin, generally leaving 3 or 4 vertical series of scales exposed between its tip and base of ventral; its length 17 to 20 percent of standard length, average 18.7 percent of standard length in 262 specimens; composed of 15 to 18, average 17.5 rays, in 213 specimens.	Pectoral fin generally longer, often nearly reaching base of ventral, seldom leaving more than 2 vertical rows of scales exposed between its tip and base of ventral; its length 19 to 23 percent of standard length, average 20.9 percent in 87 specimens; composed of 14 to 17, average 15.6 rays, in 110 specimens.
Total number of vertebrae 47 to 49, rarely 45, 46 or 50, average 48 in 194 specimens.	Total number of vertebrae 45 to 47, rarely 42, 43, 44 or 48, average 45.8 in 117 specimens.
Total number of ventral scutes 30 to 35, average 32.5 in 237 specimens.	Total number of ventral scutes 28 to 32, average 29.8 in 152 specimens.

Range.—Known from the Gulf of Mexico, from Appalachicola (also reported from Tampa), Fla., to Brazos Santiago, Tex.; adults generally taken in outside waters running high in salinity.

BREVOORTIA PECTINATA Jenyns

LACHA, SAVELHA

FIGURE 4

Alosa pectinata JENYNS, 1842, p. 135, pl. 25, Bahia Blanca, Argentina (original description).

Clupea pectinata GÜNTHER, 1868, p. 437, "Northern Patagonia" (description).—BERG, 1895, p. 18, "Mar del Plata.—Montevidéo.—Embocadura del Rio de la Plata" (reported abundant in the winter in the Rio de la Plata).—POZZI and BORDALE, 1935, p. 155, Argentina (name only).

Brevoortia pectinata GOODE, 1878b, p. 38; 1879, p. 18, pl. 6 (compared with other American forms; description).—REGAN, 1917, p. 301 (synonymy; description; range).

Brevoortia tyrannus EVERMANN and KENDALL (not of Latrobe), 1906, p. 74, Rio de la Plata, Argentina (synonymy, partly not this species; a comparison of South American examples, consisting in part of *pectinata* and probably in part of *aurea*, with North American specimens; differences noted, but not considered of specific importance).—THOMPSON (not of Latrobe) 1916, p. 405, Montevideo, Uruguay. (Note: A re-examination of the specimens shows that they are *B. pectinata*.)—DEVINCENZI (not of Latrobe) 1924, p. 187 (references; enumerations; remarks).

B. pectinata *imperfectly known.*—Although this species is well marked, it has not always been recognized by authors, as shown by the foregoing synonymy. Therefore, it seems desirable to offer a somewhat detailed description, which is possible now that rather adequate material is available.

Description.—Head 29.5 to 33 percent of standard length, its depth 28 to 31.5; depth of body 34 to 42; snout 7.0 to 8.5; eye 5.2 to 7.2; maxillary 13.5 to 16; mandible 15 to 18.5; interorbital (bone) 6.5 to 7.4; caudal peduncle, depth 10.5 to 12.6; ventral fin 8.5 to 10; pectoral fin 17.5 to 21; lower lobe of caudal fin 33 to 37; anal base 17 to 21. Dorsal rays 17 to 20, usually 18 or 19; anal rays 19 to 22; pectoral rays 15 to 17, rarely 13 or 14; scales, oblique series crossing middle of side, 35 to 46, vertical series between tip of pectoral and base of ventral 0 to 3; longitudinal series laterally on caudal peduncle 5; modified scales in a series on back in front of dorsal fin 32 to 47; ventral scutes 29 to 32; vertebrae 45 to 47 (enumerated in 6 specimens).

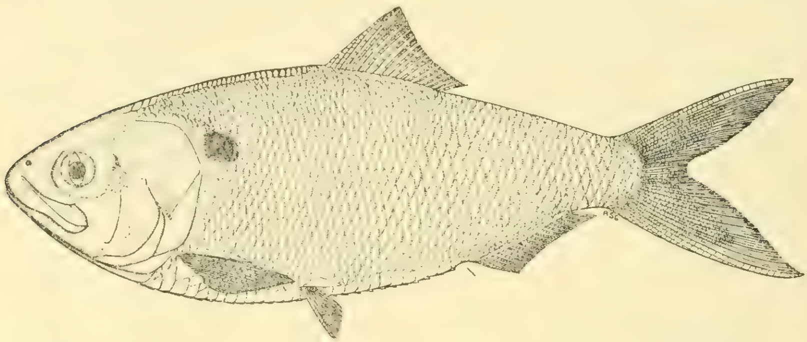

FIG. 4.—*Brevoortia pectinata,* based on a specimen 290 mm. in total length, 223 mm. in standard length (M.C.Z. No. 17636), from Rio Grande, Brazil.

Body rather strongly compressed, its greatest thickness usually only about a third of its depth, its greatest depth generally a little in advance of origin of dorsal, 2.4 to 2.9 in standard length; ventral outline scarcely more strongly convex than the dorsal; only about half the greatest depth below a straight line extending through the lower margin of eye to middle of base of caudal; caudal peduncle well compressed, its depth 2.6 to 3.1 in head, 3.2 to 3.55 in greatest depth; head, length 3.0 to 3.4 in standard length, its depth 3.2 to 3.55; snout 3.7 to 4.4 in head; eye 5.5 to 7.0; maxillary rounded, reaching nearly or quite to vertical from posterior margin of eye, 2.1 to 2.3; interorbital (bone) 4.2 to 4.8; upper section of opercle with rather feeble radiating striae or none; mandible well included in upper jaw, its length 1.7 to 1.85 in head; gill rakers long, very numerous, the longest ones in adults nearly as long as the snout and half the eye, increasing in number with age and growth, about 75 on lower limb of first arch in specimens 45 mm. long, about 135 in specimens 160 mm. long, and 200 or more in specimens 300 mm. and upward in length; scales large, closely imbricated, the exposed part about four times as deep as long, the depth of the scale itself only about 125 percent of its length, the serrae rather short and blunt (see fig. 8, D), the scales much less reduced in size on the back than in North American species, and scarcely reduced at base of caudal, in fairly regular series; 5 longitudinal rows of scales on side of caudal peduncle; a row of enlarged modified scales on each side of median line of back in front of dorsal fin, quite variable in number, not fully developed in specimens under about 125 mm. in total length; ventral scutes moderately developed, rather stronger in small specimens than in large ones, 17 or 18, rarely 16 or 19, in front of ventral fins, and 12 to 14, usually 13 or 14, behind them; dorsal fin moderately high anteriorly, the longest rays nearly as long as snout and eye, the last ray only a little longer than the immediately preceding ones, the margin of fin definitely concave, with a very narrow sheath of scales at base, the origin of the fin equidistant from margin of snout and base of caudal, or a little nearer the latter; caudal rather deeply forked, the lobes long, the lower one a little longer than head, 2.7 to 3.0 in standard length; anal fin lower than the dorsal, its margin scarcely concave, with a very narrow sheath of scales at base, its origin about under tip of last ray of dorsal, its base 5.0 to 5.9 in standard length; ventral fin with an oblique nearly straight margin, the innermost ray generally about two-thirds the length of the outermost one, length of fin 3.0 to 3.7 in head (see fig. 9, D); pectoral fin long, very slightly falcate in large specimens, sometimes nearly or quite reaching base of ventral, occasionally failing to reach ventral by a distance fully as great as diameter of pupil, leaving 0 to 3 scales exposed between its tip and base of ventral, its length 5.0 to 5.7 times in standard length, and 1.55 to 1.8 in head; axillary appendage of pectoral rather long in large examples, very short in young, 2.25 to 3.4 in head in examples 200 mm. and upward in length.

Color of preserved specimens bluish gray above, sides silvery; a large black shoulder spot present in adults, not followed by smaller dark spots, shoulder spot missing in specimens under about 90 mm. in length; fins plain, except for dusky punctulation on the dorsal and caudal.

Study material.—The foregoing description is based on 22 specimens, 160 to 365 mm. in total length, 126 to 292 mm. in standard length. In addition a couple of dozen young, ranging from 43 to 110 mm. in total length, 33 to 87 mm. in standard length, are at hand. Enumerations of fin rays and ventral scutes of 13 of these small specimens are included in the description. The proportions based on these small individuals were not used as they would distort the picture because of their slender bodies, short fins, large eyes, and other juvenile characters. The specimens are in part in the United States National Museum, Washington, D. C., and in part in the Museum of Comparative Zoology, Cambridge, Mass. The place of collection is not definitely stated for some of the specimens. The data as to localities are quoted from the labels as follows: Rio Grande of Brazil, S. A.; Montevidéo; off Montevidéo; Uruguay; Uruguay River; Paraguay [2]; Rio Plata and sea; and Buenos Aires.

Relationship.—This species, like its South American congener *aurea,* differs from the North American species in having the scales on the dorsal part of the body and at the base of the caudal fin much less reduced in size. In the shape of the ventral fin they differ from *tyrannus* and *patronus,* but agree with *smithi* and *gunteri,* the outermost ray being much longer than the innermost one, giving the fin an oblique margin, which is nearly straight. In *tyrannus* and *patronus* on the other hand the outermost ray is not much shorter than the innermost one, and the margin of the fin is definitely convex (see fig. 9). The number of oblique series of scales that cross the middle of the side in the South American species falls within the range of *tyrannus* and *patronus,* and therefore is lower than in *smithi* and *gunteri.* The South American species agree with *smithi* and *gunteri* in having no small spots on the side behind the large black shoulder spot, and disagree in this respect with *tyrannus* and *patronus.* The differences between the two South American species recognized herein are set forth in a parallel comparison in the account of *aurea.*

Abundance.—*B. pectinata,* according to Berg (1895, p. 18), is abundant during the winter in the La Plata region, and it penetrates the Rio de la Plata, but seemingly not above brackish water. This author, as well as Pozzi and Bordale (1935, p. 181), used the common name "Lacha" for this species and also for *aurea,* while von Ihering (1940, p. 721) called them "Savelha."

Range.—The distribution of this species, so far as known, is shown by the localities given in the foregoing synonymy, and by the localities listed from which specimens were examined in this study. According to these the range extends from the "Rio Grande of Brazil" to Bahia Blanca, Argentina.

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[2] The specimens labeled "Paragua" (U.S.N.M. No. 1709), according to Dr. João de Paiva Carvalho, S. Paulo, Brazil (personal communication), very probably were taken in Paranagua Bay, situated on the northern part of the coast of the state of Parana, Brazil, where Capt. Paige, aboard the U. S. S. *Waterwitch,* seems to have collected.

BREVOORTIA AUREA (Agassiz)

LACHA, SAVELHA

FIGURE 5

Clupanodon aureus AGASSIZ, *in* Spix and Agassiz, 1829, p. 52, pl. 21 (in color), Bahia, and elsewhere on the coast of Brazil (original description).

Alausa aurea CUVIER and VALENCIENNES, 1847, p. 427 (this species compared with *Clupea menhaden* = *B. tyrannus;* description).

Clupea aurea GÜNTHER, 1868, p. 437 (description).

Brevoortia tyrannus var. *aurea* GOODE, 1878b, p. 33; 1879, p. 17, pl. 3 (regarded as a geographical variety; deviation from typical *B. tyrannus* stated).—JORDAN and EVERMANN, 1896, p. 434 (compared with typical *B. tyrannus*).

Brevoortia tyrannus BERG (not of Latrobe), 1895, p. 20, "Mar del Plata.—Montevidéo.—Rio de la Plata" (synonymy, largely not this species; appearing in great schools).—SCHREINER and RIBEIRO (not of Latrobe), 1903, p. 92, "Bahia Guanabara," Brazil.—DEVINCENZI and BARATTINI, 1928, pl. 17, fig. 3, Uruguay, where *B. tyrannus* does not occur (figure apparently a somewhat altered copy from Goode, 1879, pl. 1).—POZZI and BORDALE, 1935, p. 155, Argentina (name only).

Brevoortia pectinata FOWLER (not of Jenyns), 1940, p. 745, fig. 8, Rio Janeiro, Brazil. (Note: The specimen on which this record is based (U.S.N.M. No. 83151) is at hand and proves to be *B. aurea*.)

B. aurea *imperfectly known*.—This species has often been considered identical with *tyrannus* or only subspecifically distinct from it, as shown by the foregoing synonymy. For the lack of specimens for comparison, the species has not been adequately described. As a fair series of specimens of this and related species is now available, the following somewhat detailed description is offered.

Description.—Head 28.3 to 33.6 percent of standard length, its depth 26.3 to 30; depth of body 34.4 to 39.2; snout 7.0 to 8.5; eye 6.0 to 7.25; maxillary 12.5 to 15.5; mandible 15.5 to 18.5; interorbital (bone) 6.4 to 7.4; caudal peduncle 9.0 to 12.5; ventral fin 7.5 to 9.0; pectoral fin 16.7 to 18; lower lobe of caudal 31 to 35; anal base 16.2 to 19.8. Dorsal rays 18 or 19; anal rays 19 to 24, usually 21 or 22; pectoral rays 15 or 16, occasionally 14; scales, oblique series crossing middle of side, 48 to 55; vertical series between tip of pectoral and base of ventral 3 to 6; longitudinal series laterally on caudal peduncle 7; modified scales in a series on back in front of dorsal fin 35 to 46; ventral scutes 30 to 33; vertebrae 45 or 46 (enumerated in 2 specimens).

Body rather strongly compressed, its greatest thickness about a third of its greatest depth, its greatest depth generally somewhat in advance of insertion of ventral fins, 2.55 to 2.9 in standard length; ventral outline scarcely more convex than the dorsal, about half the greatest depth below a straight line extending through the lower margin of eye to middle of base of caudal; caudal peduncle well compressed, its depth 2.6 to 3.6 in head, 3.25 to 3.85 in greatest depth; head, length 3.0 to 3.5 in standard length, its depth 3.3 to 3.8; snout 3.9 to 4.4 in head; eye 4.4 to 5.3; maxillary round posteriorly, reaching about under posterior margin of pupil, 2.15 to 2.33 in head; interorbital (bone) 3.95 to 5.0 in head; upper section of opercle with feeble radiating striae or none; mandible fully included in upper jaw, its length 1.8 to 1.9 in head; gill rakers very long and slender, the longest ones in adults somewhat longer than snout, increasing in number with age, about 137 in a specimen 160 mm. in total length, and about 225 in a specimen 285 mm. in total length; scales small, not closely imbricated, exposed part of scale rather less than three times as deep

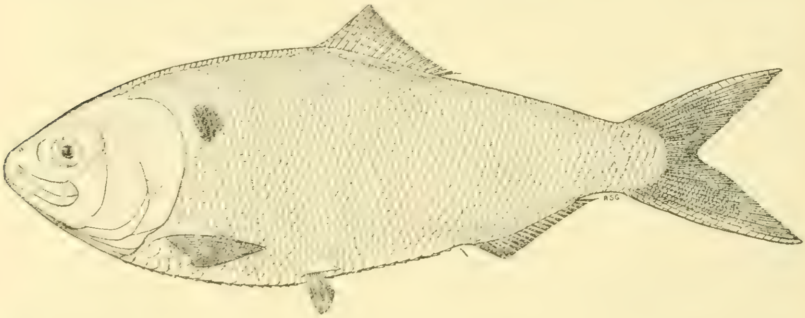

FIG. 5.—*Brevoortia aurea,* based on a specimen 280 mm. in total length, 225 mm. in standard length (M.C.Z. No. 17831), from Rio Janeiro, Brazil.

as long, the depth of the scale about 140 percent of its length, the serrae not very long nor sharply pointed (see fig. 8, C; scale from a fish about the same length as that in fig. 8, D), shorter and blunter in smaller fish than in large ones, the scales much less reduced in size on the back than in North American species, and scarcely reduced in size at base of caudal, in fairly regular series; 7 longitudinal rows of scales on side of caudal peduncle; the row of enlarged modified scales on each side of median line on the back in front of dorsal fin rather variable in number; ventral scutes fairly strong, 17 to 20, usually 18, in front of ventral fins and 12 to 15 behind them; dorsal fin moderately elevated anteriorly, the longest rays scarcely as long as snout and eye, the last ray only a little longer than the immediately preceding ones, the margin of the fin definitely concave, with a very narrow sheath of scales at base, the origin of the fin generally about equidistant from margin of snout and base of caudal; caudal moderately forked, rather short, the lower lobe a little longer than head, 2.85 to 3.2 in standard length; anal fin low, its margin nearly straight, with a very narrow sheath of scales at base, its origin about under tip of last ray of dorsal, its base 5.25 to 6.1 in standard length; ventral fin with an oblique and somewhat convex margin, the innermost ray about two-thirds the length of the outermost one, the length of fin 3.5 to 4.25 in head (see fig. 9, C); pectoral fin short, not falcate, failing to reach base of ventral by a distance varying from half to a whole diameter of eye, leaving 3 to 6 scales exposed between its tip and base of ventral, its length 5.6 to 6.0 in the standard length, and 1.8 to 2.0 in head; axillary appendage moderately long in large examples, short in small ones, 2.2 to 4.7 in head.

Color of preserved specimens dark grayish on back; sides yellowish to brassy; a large black shoulder spot, not followed by smaller dark spots; fins all plain.

Study material.—The foregoing description is based on 15 specimens 110 to 285 mm. in total length, 87 to 223 mm. in standard length. These specimens are in part in the United States National Museum, Washington, D. C., and in part in the Museum of Comparative Zoology, Cambridge, Mass.; the place of collection is not always definitely stated for some of the specimens. The data as to localities are quoted from the labels as follows: Sambaia,[3] Rio Janiero, and Paraguay.[4]

Relationship, and a parallel comparison.—The general relationship of this species and the North American members of the genus is shown in the account of *pectinata* (p. 24). It differs from its South American congener in the notably smaller scales, a difference actually greater than shown, by the enumerations given in the description. If scales from the middle of the side below the origin of the dorsal are compared with those of *pectinata* from the same part of the body, and in examples of equal size, those of *aurea* are only about two-thirds as large as those of *pectinata.* This prominent difference is not fully evident from the enumeration of the oblique series along the middle of the side because the scales are less closely imbricated in

[3] These specimens were collected by the Thayer expedition to Brazil. Sambaia could not be found on any map at hand. Accordingly the Brazilian ichthyologist, Dr. João de Paiva Carvalho, was consulted, who replied by letter that there apparently is no Sambaia in Brazil, and suggested that the Sambara River, one of many coastal streams between Bahia and Rio de Janeiro, might be intended. He pointed out that the "r" in Sambara might somehow have been changed to "i"; a very plausible explanation.

[4] See footnote 2, under *B. pectinata* (p. 24) for an explanation of the locality "Paraguay."

aurea. Other differences are shown in the following parallel comparison.

aurea	*pectinata*
Scales small, 48 to 55 oblique series crossing middle of side, not closely imbricated, the length of the exposed part of each scale on middle of side usually about a third of the depth of that part of the scale, 7 longitudinal rows on side of caudal peduncle, 3 to 6 vertical series between tip of pectoral and base of ventral fin.	Scales larger, 35 to 46 oblique series crossing middle of side, notably more closely imbricated, the length of the exposed part of each scale on middle of side about a fourth of the depth of that part of the scale, 5 longitudinal rows of scales on side of caudal peduncle, 0 to 3 vertical series between tip of pectoral and base of ventral fin.
Fins short, the pectoral failing to reach base of ventral by a distance varying from half to a full diameter of eye, 5.6 to 6.0 in standard length, 1.8 to 2.0 in head; ventral fin 3.5 to 4.25 in head; lower lobe of caudal 2.85 to 3.2 in standard length.	Fins longer, the pectoral sometimes reaching base of ventral, occasionally falling short of this point by diameter of pupil, 5.0 to 5.7 in standard length, 1.55 to 1.8 in head; ventral fin 3.0 to 3.7 in head; lower lobe of caudal 2.7 to 3.0 in standard length.

Range.—The type locality, as given by Agassiz (Spix and Agassiz, 1829, p. 52), is Bahia and elsewhere on the coast of Brazil. Bahia seems to remain the northernmost known limit of the range, whence it extends at least to the Rio de la Plata, if Berg's (1895, p. 20) determination is correct. There are no specimens at hand from farther south than Rio de Janeiro, Brazil.

BREVOORTIA SMITHI Hildebrand

YELLOWFIN SHAD

FIGURE 6

Brevoortia aureus HILDEBRAND (not of Agassiz), 1919, p. 7, with fig., and pl. 1, fig. 2, Beaufort, N. C. (original description of *B. smithi* Hildebrand (see next reference); compared with *B. tyrannus;* local occurrence; habits; food).

Brevoortia smithi HILDEBRAND, 1941, p. 224 (*B. aureus,* Hildebrand (see above) recognized as distinct from *B. aureus* (Agassiz) and as without a name; *B. smithi* proposed; reference to original description; specimen bearing U.S.N.M. No. 118723 designated as type).

On the identity of B. smithi.—The present writer, as shown by the synonymy given, at first considered this menhaden identical with *B. aureus* (Agassiz) from Brazil, and described specimens from Beaufort, N. C., under that name. However, many years later when the opportunity came to compare the North Carolina material with South American specimens he arrived at the conclusion that the specimens from the two areas represented distinct species. As the one represented by the specimens from North Carolina seemed to be without a name, *B. smithi* was proposed.

Source of the data and their presentation.—The following list of proportions and enumerations is based on the 18 specimens in the National Museum collection, which range from 120 to 315 mm. in total length, and from 91 to 240 mm. in standard length. Ten of these specimens (Nos. 84368, 118723 (the type), 125939 to 125947, 125950, 125953, and 125955) are from Beaufort, N. C., one (No. 119236) from Cumberland Sound, Ga., five (No. 18049) from the mouth of the St. Johns River, Fla., and two (No. 7696) from Indian River, Fla. The range in the percentage of the standard length of the

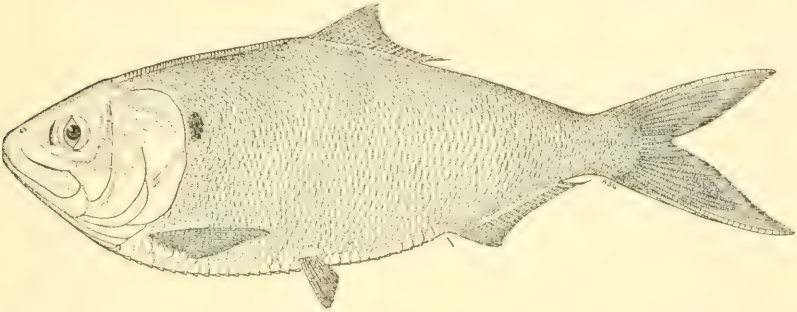

FIG. 6.—*Brevoortia smithi*, based on the holotype, 295 mm. in total length, 225 mm. in standard length (U.S.N.M. No. 118723), taken at Beaufort, N. C.

parts measured is given first in each instance, followed by the proportion based on the type, and then the proportion in the standard length or in the head is enclosed in parentheses. The enumerations are given in the same order.

Some proportions and enumerations.—Head 29 to 31.5, 30.6 (3.2 to 3.45, 3.25), its depth 27.3 to 31, 29 (3.25 to 3.65, 3.45); depth of body 36 to 43, 38 (2.3 to 2.75, 2.6); anal base 19 to 21, 20 (4.75 to 5.25, 5.0); lower lobe of caudal 32 to 37, 33.3 (2.7 to 3.1, 3.0); depth of caudal peduncle 9.5 to 12, 10.2 (2.6 to 3.4, 3.0 in head); eye 6.1 to 7.5, 6.1 (4.2 to 5.2, 5.0 in head); snout 6.8 to 8.0, 8.0 (3.7 to 5.0, 3.85 in head); interorbital (bone) 6.2 to 7.7, 6.2 (4.0 to 4.9, 4.9 in head); maxillary 13.2 to 15, 15 (2.0 to 2.4, 2.0 in head); mandible 16.5 to 18.5, 17.5 (1.7 to 1.9, 1.75 in head); pectoral fin 18.5 to 21.5, 21.5 (1.45 to 1.75, 1.45 in head); axillary appendage of pectoral 8.6 to 12, 11 (2.6 to 4.0, 2.75 in head). Dorsal rays 18 to 20, 18; anal rays 22 to 24, 23; pectoral rays 15 to 17, 16; scales, oblique series crossing middle of side (too irregular to enumerate accurately), about 60 to 70, 64; vertical series of scales between tip of pectoral and base of ventral 5 to 8, 5; modified scales in a series in front of dorsal fin 39 to 45, 45; ventral scutes 30 to 33, 31; gill rakers on lower limb of first arch about 125 to 149 (enumerated in 6 specimens); vertebrae 45 to 47 (enumerated in 9 specimens).

Relationship.—*B. smithi* is close to *B. gunteri* n. sp., which is its counterpart in the Gulf of Mexico. The relationship of these two species is shown in the account of the last-mentioned species. *B. smithi* differs rather prominently from *B. tyrannus,* with which it was long confused, as shown in the following comparison. As the proportions and enumerations for *tyrannus* are based on 200 specimens or more, the "usual" range can be stated, but that is not possible for *smithi* of which only 18 specimens are at hand.

tyrannus	*smithi*
Scales moderately large, arranged in fairly regular series, 41 to 55, usually 45 to 52, oblique series crossing middle of side; scales on middle of side with long, hairlike pectinations in large examples (see fig. 8, B), modified scales on back in front of dorsal fin with long hairlike pectinations in adults, 31 to 43, usually 33 to 39 in a series.	Scales notably smaller and less regularly placed, about 60 to 70 oblique series crossing middle of side; scales on middle of side with notably shorter and blunter pectinations in large examples (see fig. 8, F); modified scales on back in front of dorsal fin with notably shorter and blunter pectinations in adults, 39 to 45 in a series.
Upper part of opercle with prominent radiating striations.	Upper part of opercle with very feeble striations, or none.
Head moderately large, 28 to 35, usually 31 to 34, average 32.2 percent of standard length.	Head smaller, 29 to 32, average 30.7 percent of standard length.
Body moderately deep, the ventral outline anteriorly moderately convex, usually only half the greatest depth below a straight line extending through lower margin of eye to middle of base of caudal, its greatest depth 30 to 39, usually 32 to 37, average 34.2 percent of standard length.	Body rather deeper, the ventral outline anteriorly more strongly convex, more than half the greatest depth below a straight line extending through lower margin of eye to middle of base of caudal, its greatest depth 36 to 43, average 38.7 percent of standard length.
Anal base rather short, 14 to 19, usually 15 to 18, average 16.5 percent of standard length.	Anal base longer, 19 to 21, average 19.9 percent of standard length.
Caudal fin rather short, the lower lobe about as long as head, 25 to 35, usually 26 to 33, average 29.4 percent of standard length, if measured from middle of base of caudal.	Caudal fin longer, the lower lobe longer than head, 32 to 37, average 33.8 percent of standard length, if measured as in *tyrannus*.

tyrannus	*smithi*
Ventral fin with a gently convex margin, the innermost ray only a little shorter than outermost one (see fig. 9, B).	Ventral fin with an oblique margin, the innermost ray only about half as long as the outermost one (see fig. 9, F).
Color dark green to bluish above, sides generally brassy green; fins pale yellow to brassy; shoulder spot followed by a variable number of smaller dark spots, body sometimes profusely spotted anteriorly in adults	Color lighter, bluish green above, sides silvery; fins golden yellow; shoulder spot not followed by smaller dark spots, the sides being plain, unspotted.

In addition to the morphological differences between *tyrannus* and *smithi,* indicated in the parallel comparison, it should be stated that the latter is a much more active fish, which when caught in a seine makes a vigorous effort to escape, whereas the former generally strikes the net once and then allows itself to be hauled in without making a further effort to flee. Furthermore, *smithi* is not known to school and it is not known to be numerous anywhere, generally only a few individuals at a time being taken. It differs still further from *tyrannus* in being almost devoid of mucus, whereas *tyrannus* is densely coated with mucus. As a result, fresh specimens may be identified by the touch, as *smithi* is not slippery while *tyrannus* is very slippery.

The fishermen at Beaufort, N. C., recognize *smithi* as different from *tyrannus,* and call it the "yellowfin shad," whereas the latter is simply called "shad" or "fatback." They consider its edible qualities superior to that of *tyrannus,* and generally keep the few they catch for their own tables.

Range.—Known from Beaufort, N. C., to the "Indian River," presumably Indian River City, Fla.

BREVOORTIA GUNTERI new species

Fine-scale Gulf Menhaden

Figure 7

Brevoortia patronus Goode (in part not *patronus*), 1878b, p. 39, Brazos Santiago, and mouth of Rio Grande, Tex. (diagnosis and tables of measurements in part based on specimens from the mouth of the Rio Grande, which are *B. gunteri* n. sp.).

Brevoortia sp. Gunter, 1945, p. 27, Compano and Aransas Bays, Tex. (recognized as differing from *B. patronus* in having more silvery, less green color, as having a sharper snout, a "differently-shaped head" and much smaller scales).

On the identity of B. gunteri.—Specimens of this species, as indicated in the foregoing synonymy, were included in Goode's type material of *B. patronus,* wherein examples of two species were confused. It is fortunate that Goode stated that his description was based on specimens from Brazos Santiago, Tex., which definitely make Goode's name, *B. patronus,* available for the large-scale Gulf menhaden, and leaves the fine-scale one without a name. The situation is explained in more detail in the account of *B. patronus* (p. 14).

Gunter (1945, p. 27) recognized this species as different from *B. patronus,* which he designated *B. tyrannus.* However, he did not recognize it as new and he did not offer a formal description, though he did say, "The writer suddenly became aware after months of work on the Texas coast that 2 species of *Brevoortia* were present. . . . . The second species was much more common, lived in waters of lower

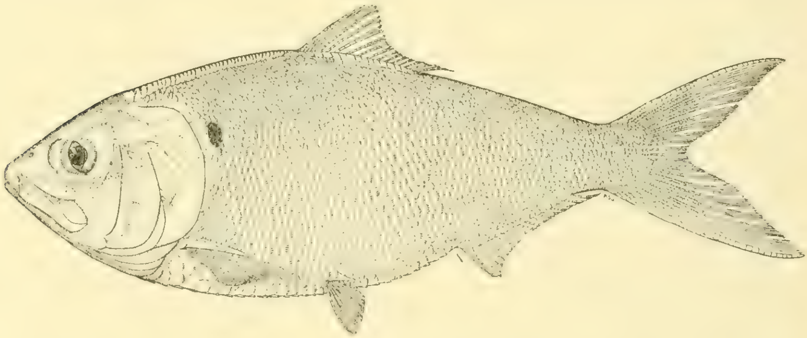

FIG. 7.—*Brevoortia gunteri* n. sp., based on the holotype, 270 mm. in total length, 205 mm. in standard length (U.S.N.M. No. 129798), taken in Aransas Bay, Rockport, Tex.

salinity, was more silvery and had less green color, had a sharper snout and a differently shaped head, had much smaller scales and was not slimy." Gunter thought that this might be the "original *B. patronus* of Goode," but it seemed to him that it was "rather close to or possibly identical with the *B. smithi* of Hildebrand." Mr. Gunter was wrong, as already stated, in believing that his specimens, with small scales, might be *B. patronus,* but he was correct when he said they were close to *B. smithi,* though they are not identical with it.

It affords me pleasure to name this species for Gordon Gunter, in recognition of his good work on the aquatic animals of the Gulf coast, and in appreciation of the very fine series of specimens he has furnished me for this study. A description of this species follows, wherein proportions and enumerations pertaining to the type are enclosed in parentheses.

Description.—Head 31 to 35.5, usually 32 to 34 (32) percent of standard length, its depth 29 to 35.5, usually 30.5 to 32 (31); depth of body 37 to 45, usually 38 to 41 (40.5); snout 7.0 to 10 (9.3); eye 6.6 to 9.5 (6.8); maxillary 14.5 to 17.5, usually 15.5 to 16.5 (16); mandible 17.5 to 20.5, usually 18.5 to 19 (19.5); interorbital (bone) 7.0 to 8.0 (7.3); caudal peduncle, depth 9.5 to 12.2, usually 10 to 11 (11); ventral fin 9.3 to 11 (9.3); pectoral fin 19 to 23.5, usually 20 to 22 (21.5); lower lobe of caudal fin 32 to 39, usually 34 to 37 (35.5); anal base 19 to 23, usually 20.5 to 22.5 (21). Dorsal rays 17 to 20, usually 18 or 19 (18); anal rays 20 to 25, usually 22 to 24 (22); pectoral rays 15 or 16, rarely 14 (15); scales, oblique series crossing middle of side, about 60 to 75 (61); modified scales in a series in advance of dorsal fin, 35 to 45, usually 38 to 42 (42); ventral scutes 27 to 30, usually 28 or 29 (29); vertebrae 43 or 44, rarely 42 (enumerated in 22 paratypes).

Body very strongly compressed (for a menhaden), its greatest thickness only about a third of its depth, its greatest depth a little in advance of origin of dorsal and a little in advance of tip of pectoral, 2.2 to 2.7, usually 2.43 to 2.6 (2.47) in standard length; ventral outline more strongly convex than the dorsal, much more than half the depth below a straight line extending through lower margin of eye to middle of base of caudal; caudal peduncle rather deep, 2.7 to 3.5 (2.85) in head, and 3.6 to 4.0 (3.6) in greatest depth; head 2.7 to 3.2 (3.1) in standard length, its depth 2.75 to 3.4 (3.2); snout compressed, with a sharp median notch, its length 3.4 to 4.4 (3.45) in head; eye 3.6 to 4.8, usually 4.2 to 4.7 (4.6); maxillary broadly rounded, reaching to or a little beyond vertical from posterior margin of pupil, 1.8 to 2.2, usually 2.0 to 2.1 (2.0); interorbital (bone) 4.1 to 4.7 (4.4); upper section of opercle with very feeble radiating striae or none; mandible well included in upper jaw, its length 1.55 to 1.95 (1.65) in head; gill rakers long, the longest ones somewhat exceeding length of snout, 97 on lower limb of first arch in a specimen 70 mm. in total length, 113 to 123 in three specimens respectively 103, 113, and 113 mm. long, and 135 to 150 in four specimens 200 to 300 mm. in total length; teeth missing in all specimens at hand; scales closely adherent, the exposed part three to four times as deep as long, the scale itself about two-thirds as deep as long, with prominent serrae in adults, ending in somewhat blunted points (see fig. 8, E); the scales much reduced in size on back and at base of caudal, in rather irregular series (difficult to enumerate accurately); the row of enlarged, modified scales on each side of median line on back in front of dorsal fin not fully developed in young under about 110 mm. in total length; ventral scutes weaker in large examples than in smaller ones, 17 or 18, usually 17 (17) in front of ventral fins, and 10 to 13, usually 11 or 12 (12) behind them; dorsal fin rather high anteriorly, the longest rays about as long as snout and half the eye, the last ray considerably longer than the immediately preceding ones, the margin of the fin rather deeply concave, the base of fin with a very narrow sheath of scales at base, the origin of the fin generally about equidistant from margin of snout and base of caudal; caudal deeply forked, the middle rays about as long as eye, the lobes long, the lower one the

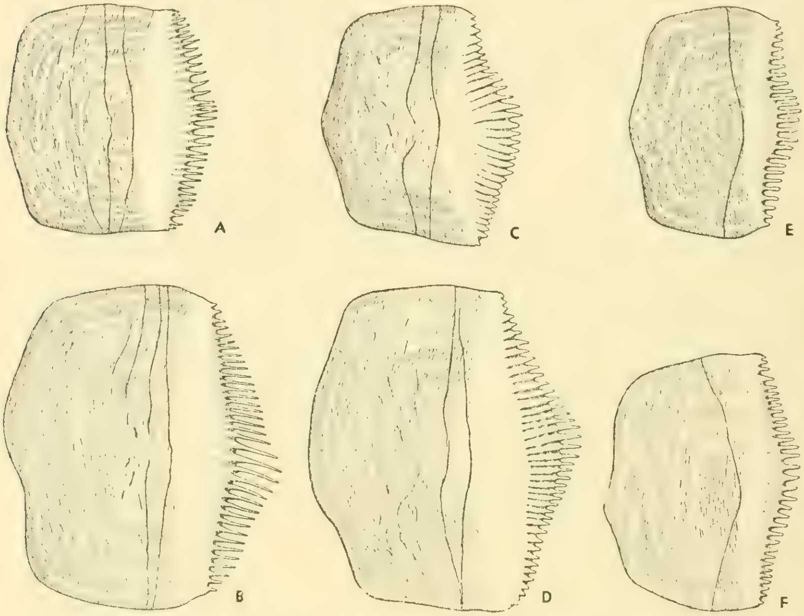

FIG. 8.—Scales of species of *Brevoortia* from middle of side below anterior rays of dorsal; all equally enlarged. A, *patronus,* from a specimen 215 mm. in total length; B, *tyrannus,* from a specimen 320 mm. in total length; C, *aurea,* from a specimen 280 mm. in total length; D, *pectinata,* from a specimen 290 mm. in total length; E, *gunteri,* from a specimen 270 mm. in total length; F, *smithi,* from a specimen 295 mm. in total length.

longer, exceeding length of head, 2.55 to 3.3, usually 2.8 to 2.9 (2.8) in standard length; anal fin much lower than dorsal, its longest rays only about two-thirds length of those of dorsal, its margin somewhat concave, with a very narrow sheath of scales at base, its origin under or a little in advance of tip of last ray of dorsal, its base 4.45 to 5.25 (4.75) in standard length; ventral fin with an oblique, nearly straight margin, the outermost ray somewhat less than twice the length of the innermost one (see fig. 9, E), the fin inserted a little behind vertical from origin of dorsal, length of fin 2.9 to 3.4 (3.0) in head;

pectoral fin long, slightly falcate, the longest ray fully four times as long as the shortest one, the fin failing to reach base of ventral by a distance equal to or more usually a little less than diameter of pupil, leaving about 2 to 4 vertical series of scales exposed between its tip and base of ventral, its length 4.25 to 5.25 (5.0) in standard length, and 1.4 to 1.9 (1.5) in head; axillary appendage of pectoral variable in length, apparently increasing in length with age, usually about half length of fin in large examples, and only about a third in small examples, 2.5 to 4.6 (2.85) in head.

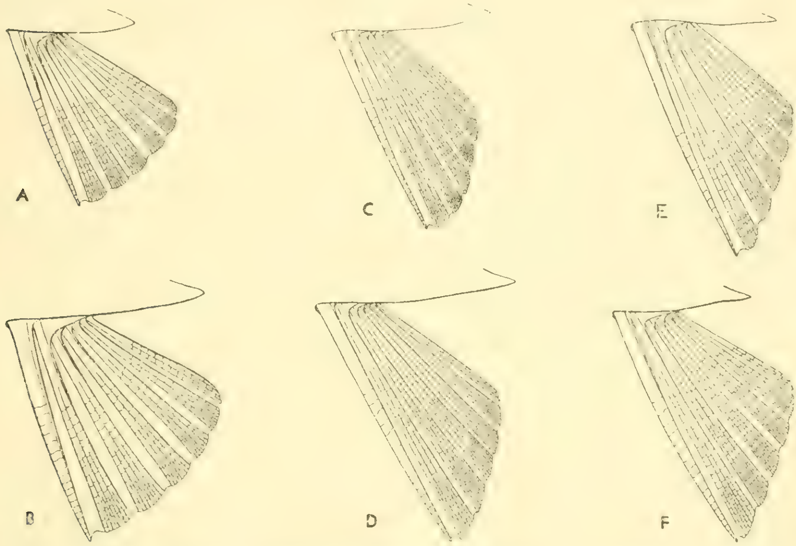

FIG. 9.—Ventral fins of species of *Brevoortia,* from the specimens illustrated in figures 1, 3, 4, 5, 6, and 7; all equally enlarged. A, *patronus;* B, *tyrannus;* C, *aurea;* D, *pectinata;* E, *gunteri;* F, *smithi.*

Color of preserved specimens dark gray above a straight line extending through upper margin of eye to slightly above middle of base of caudal, changing rather abruptly to silvery on side; a large black shoulder spot present in adults, only faintly visible in specimens 110 to 125 mm. long, missing in smaller ones, this spot not followed by smaller ones; dorsal and caudal fins somewhat dusky, the margin of caudal pale; other fins plain translucent. Gunter (1945, p. 27) remarked, in comparing fresh examples of this menhaden which he termed the "second species" with *B. patronus,* "The second species . . . . was more silvery and had less green color."

Study material.—This species is represented in the collection of the National Museum by 55 specimens, 70 to 310 mm. in total length, 53 to 230 mm. in standard length. The proportions and enumerations are based on all this material unless otherwise stated. One half-grown specimen is from the vicinity of Grand Isle, La. The others are from Texas. Some were taken in the mouth of the Rio Grande, and at Brazos Santiago. These are small specimens and part of Goode's type material of *B. patronus* (1878b, p. 39), but not that species as already explained. The rest of the specimens are from the bays in the vicinity of Corpus Christi, Rockport, and Galveston. A particularly fine series of rather large and well-preserved specimens from Aransas Bay, collected and presented by Gordon Gunter, are included. The type (U.S.N.M. No. 129798), 270 mm. in total length, 205 mm. in standard length, was selected from the lot from Aransas Bay, Rockport, Tex.

Relationship.—*B. gunteri* differs prominently from *B. patronus* in having much smaller and more crowded scales, which also are much deeper and shorter, and have much shorter and blunter serrations in adults. It differs further in the much more feebly developed radiating striae or none, on the upper part of the opercle; in the absence of dark spots behind the black shoulder spot; as well as in several other respects. It is close to *B. smithi* of the Atlantic, with which it agrees in having a deep, well-compressed body, which is devoid of slime; in having small crowded scales; in the absence of dark spots on the side behind the black shoulder spot; and in several other respects. The chief differences are shown in the following parallel comparison.

smithi	*gunteri*
Head small, its length 29 to 31.5 percent of the standard length, and its depth 27.3 to 31 percent.	Head rather larger, its length 31 to 35.5, usually 32 to 34 percent of standard length, and its depth 29 to 35.5, usually 30.5 to 32 percent.
Maxillary reaching from middle of eye to posterior margin of pupil, 13 to 14.5 percent of standard length.	Maxillary reaching to or a little beyond posterior margin of pupil, 14.5 to 17 percent of standard length.
Mandible rather short, 16.5 to 18, usually 17 percent of standard length.	Mandible somewhat longer 18 to 20, usually 18.5 to 19 percent of standard length.
Pectoral fin short, generally failing to reach base of ventral by a distance somewhat greater than half diameter of eye, 5 to 8 vertical rows of scales between its tip and base of ventral, 18.5 to 21.5 percent of standard length.	Pectoral fin longer, generally failing to reach base of ventral by a distance a little less than diameter of pupil, 2 to 4 vertical rows of scales between its tip and base of ventral, 19 to 23.5, usually 20 to 22 percent of standard length.
Ventral scutes 18 or 19, usually 18, in front of ventral fins, and 12 to 14, usually 13, behind them, total number 30 to 32, usually 31.	Ventral scutes 17 or 18, usually 17, in front of ventral fins, and 10 to 13, usually 11 or 12, behind them, total number 27 to 30, usually 28 or 29.
Vertebrae 45 to 47.	Vertebrae 43 or 44, rarely 42.

Distribution.—*B. gunteri* is the counterpart in the Gulf of *B. smithi* in the Atlantic, just as *B. patronus* in the Gulf is the counterpart of *B. tyrannus* in the Atlantic. In each instance the range in geological times very probably was continuous, but in due course it became discontinuous. At least at present menhaden quite surely do not occur in southern Florida. Therefore, no intermingling can take place. Under separation and under environmental differences minor changes seem to have taken place. Although no specimens of *B. gunteri* from Florida are included in the collections examined, I do not regard that as evidence it does not occur there. For that matter, only a few specimens of *B. patronus* from Florida are at hand. Yet menhaden are numerous enough to supply a reduction plant at Port St. Joe, Fla. Probably because menhaden are common, they have not been considered of much interest to collectors, and even if many examples were taken, few were preserved.

Range.—Known from the Gulf of Mexico, from Grand Isle, La., to the mouth of the Rio Grande, Tex. Very probably occurring elsewhere in the Gulf; generally not recognized by collectors. Usually living in bays where the water runs low in salinity.

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(WITH ONE PLATE)

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AND
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(PUBLICATION 3914)

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On several occasions one or both of us have attempted to observe the distribution of heat in the spectra of stars, with a view to the estimation of their approximate temperatures and related conditions.[1] On two other occasions Abbot and Stebbins, and Abbot and Hoover, made certain observations of the sort, but these were unfortunately vitiated by effects of stray light. In all these experiments we had the privilege of observing at the Coudé focus of the 100-inch telescope on Mount Wilson, Calif. We acknowledge with grateful thanks the encouragement and assistance given us by the staff of Mount Wilson Observatory.

On September 7, 8, and 9, 1947, we made measurements with the radiometer on eight stars. The present publication is a preliminary report, showing that the way seems open to obtain good results in this manner. We hope to amplify the results and greatly improve their accuracy in a future expedition which we propose to undertake in September 1948.

In Smithsonian Publication No. 3843 (Smithsonian Misc. Coll., vol. 104, No. 22) one of us described the apparatus proposed to be used in 1946. The expedition was delayed until 1947 because it was impossible to obtain the compound prism described in Publication 3843. A substitute for it was obtained in January 1947. Various delays in setting up the apparatus at Mount Wilson in 1947 prevented us from experimenting long enough to get maximum sensitiveness with the radiometer. Hence not more than a centimeter deflection was obtained for any of the stars observed, and consequently the minute vibrations and Brownian movements of the radiometer caused rather large percentage accidental errors in the observations, as will appear below. Nevertheless the results obtained were positive, and

[1] Smithsonian Misc. Coll., vol. 74, No. 7, 1923; Contr. Mount Wilson Observ., No. 280, 1924; Contr. Mount Wilson Observ., No. 380, 1929.

fairly consistent. They lead us to expect that with more time for preparation, and more numerous observations in 1948, very interesting results may be obtained.

As pictured in figure 1, Publication 3843, the proposed prism comprised a cemented combination of a 60° Jena U.V. Crown 3199 prism with an opposed Bausch & Lomb light flint L.F.3 prism of 22° refracting angle. We knew the dispersion characteristics of the Jena glass prism from our bolographic work on the solar constant,

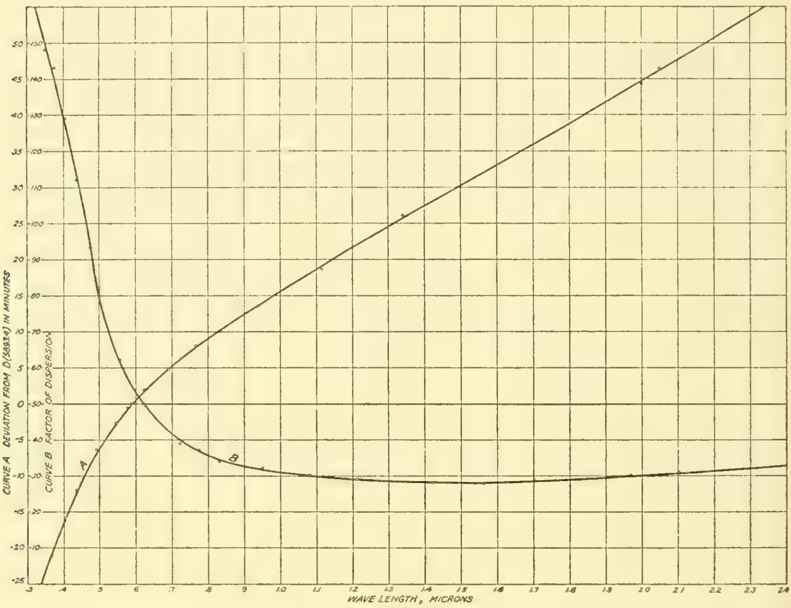


FIG. 1.—Curves of prismatic deviation, A, and wave length, and of dispersion factor, $\frac{d\theta}{d\lambda}$, B, and wave length.

and we estimated those of the L.F.3 prism by comparison with glasses listed on page 359, Smithsonian Physical Tables, 8th revised edition. From these data the curves of figure 2, Publication 3843, were computed. It proved impossible to procure Jena 3199 glass, and the cemented combination finally prepared by Bausch & Lomb was a 60° B. & L. B.S.C.1 borosilicate crown with an opposed 23° B. & L. L.F.3 light flint prism. We were unable to determine its dispersion through the desired range at Washington before the expedition, though it was partially observed with great accuracy by Hoover and Greeley. Hence at Mount Wilson we were unable to select knowingly the best wave lengths to observe in the stellar spectra, and we chose eight places more or less by guess. After completing our observing on September 7, 8, 9, Abbot took the prism to our station on Table Mountain, Calif., and with A. F. Moore made bolographs of the solar spectrum. From these bolographs, combined with the work of Hoover and Greeley, the curves shown here in figure 1 were computed.

The combination prism actually prepared is not as uniform in its dispersion as that which we hoped to obtain, whose characteristics are shown in Publication 3843, figure 2. The actual prism has a range of $\frac{d\theta}{d\lambda}$ of fivefold in dispersion between wave lengths 3300 and 22,000 A. Still it is more than twice as uniform in dispersion as a simple 60° Jena Crown glass prism, such as we use for solar-constant work, and it is almost completely uniform in dispersion between the wave lengths of the D sodium lines and 22,000 A.

Not knowing the dispersion of the prism before the observing of September 7, 8, 9, we chose places which afterward were found to have the following wave lengths:

TABLE 1.—*Places observed in stellar spectra*

Prismatic deviation from the D lines	−13′.5	−10′.8	−8′.4	−5′.4	−1′.8	+1′.8	+7′.1	+9′.5
Wave lengths, microns	0.423	0.448	0.471	0.505	0.559	0.622	0.750	0.817
Exposure range, microns	0.0140	0.0154	0.0172	0.0206	0.0248	0.0324	0.0416	0.0444

The radiometer vanes, as stated in Publication 3843, were each 0.20 millimeter high and 0.44 millimeter wide. The spectrum, as it fell upon them, extended vertically, and was intercepted by the dimension 0.20 millimeter. With the spectroscope as about to be described, this corresponded to an exposure of 2′.07 in the spectrum, and the exposures range in wave length as given in line 3, table 1 above. Thus within the wave-length interval observed in 1947 the range of dispersion was about threefold.

With a prism of such small total dispersion it was important to avoid stray light scattered from one region of spectrum to another. This we accomplished by greatly lengthening the travel of the beam after its dispersion by the prism, before focusing it by the image-forming lens. The graph, figure 2, shows the optical path schematically. It will be perceived that the range of spectrum which could fall within the radiometer is limited by the angle subtended by the lens *h* at a distance of 61 feet from the prism. This angle is 12′. At

0.423μ this corresponds to 0.08μ and at 0.813μ it corresponds to 0.25μ. However, the ends of these spectrum intervals were much weakened by obstructions within the radiometer itself. So the spectrum that could be seen in the eyepiece of the radiometer appeared only about three times as high as the radiometer vanes. The other parts of the spectrum, which might have scattered extraneous light onto the radiometer, were lost in part by overrunning the mirror *f*, and those re-

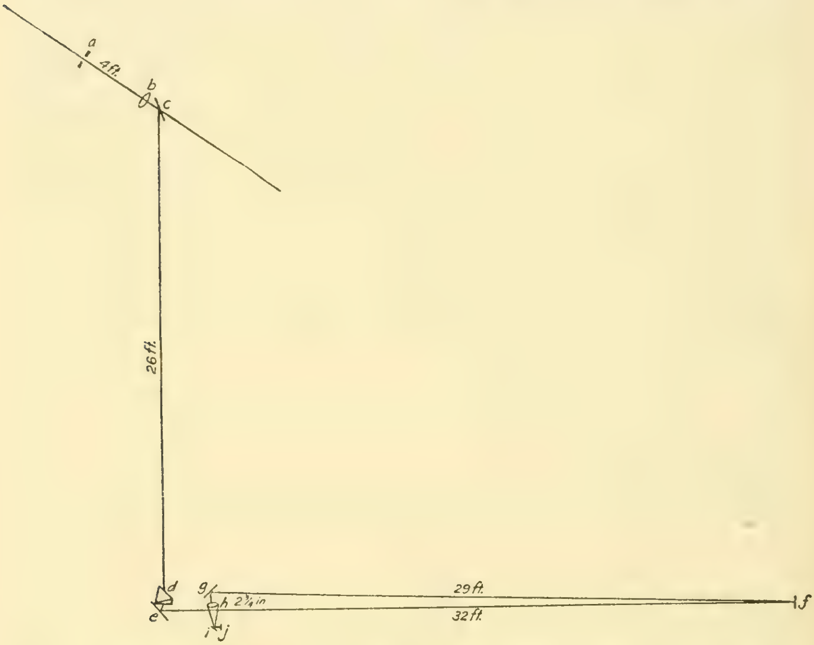


FIG. 2.—Diagram of the optical path. The star beam focused on the slit at *a* is made parallel by the quartz lens *b*. Thence it is reflected by the mirror *c* through the prism *d* onto the mirror *e*, thence to the mirrors *f* and *g* and through the quartz lens *h* to the mirror *i* which reflects it to focus on the radiometer vane at *j*.

maining were lost in large part by overrunning the mirror *g* and lens *h*. Such fragments of these extraneous spectral rays as fell on the mirror *f* and the mirror *g* were scattered over the surface of these mirrors at such angles that they must have been almost entirely lost from the observed wave-length intervals falling on the radiometer vanes. In place of a slit at the Coudé focus we used a round aperture 1.5 millimeters in diameter, so as to avoid mainly variable losses of light with changes of atmospheric "seeing."

The radiometer itself has been sufficiently described in Publication 3808. Abbot constructed a brass gadget with which he was able to dismount the radiometer suspension and pack it into a little wooden box without any chance of breaking the invisibly fine quartz fiber, or the delicate suspension. In this box he carried it in his suitcase to Mount Wilson, and within a half hour after arrival at the observing room hung it, entirely unharmed, within the radiometer case, previously leveled. Two powerful magnets reduced the time of single swing in air at radiometer pressure (about 0.2 mm. Hg.) from about 2 minutes when free, to about 10 seconds under magnetic control. With two other magnets coarse and fine adjustments in azimuth could be made, so that the spot of light for reading purposes could be brought readily to any part of the reading scale at 5 meters distance. The light spot was furnished by one short length of the filament of a 200-watt Mazda lamp, situated about 2.5 meters above the radiometer. Two pinhole diaphragms 2 meters apart limited the beam to about 6 millimeters diameter where it fell upon the quartz plate through which it entered the radiometer. The spot was further largely shorn away there by other obstructions. Still it is feared that too much light entered the radiometer in this beam. Variations of voltage of the lamp may have produced radiometrically minute vibrations of the suspension. The ordinary range of these vibrations on the scale at 5 meters was less than 1 millimeter, and sometimes hardly observable at all, yet it is hoped to reduce this range in future experiments.

The positions of the light spot on the scale, as the spectrum was swung from one vane to the other of the radiometer by pulling a cord, were read on the special device described and shown in figure 4 of Mount Wilson Observatory Contribution No. 380, of 1929. The places of the light spot were observed on a divided circle of 100 divisions, one complete revolution of which corresponded to a movement by a screw of $\frac{1}{8}$ inch, approximately 3 mm. So the positions were recorded to 0.03 millimeter. Maximum deflections in the spectra of stars ranged from about 100 to about 300 divisions. It was found in reducing the observations that the average individual deviation from the mean in a set of readings was 42 divisions. Generally four swings from one vane to the other were made at each wave length. Hence the average deviation of the mean of such a set of readings would be of $\frac{42}{2}=21$ divisions. This is from 20 down to 7 percent of the deflection at maximum in the spectra of the stars observed.

This percentage accidental error is obviously far too great to give satisfactory spectral energy curves. In future work we hope to reduce it: 1, by increasing the radiometer effect by substituting hydrogen for air, and adjusting the hydrogen pressure for largest deflection at a time of single swing of 12 seconds; 2, by excluding much more of the light from the reading-beam lamp; 3, by having means to set the focus of the image-forming lens from a distance, without approaching personally near the radiometer (we found indications of a slight temperature effect from this cause in 1947). We intend also to choose other wave lengths, so as to cover the spectrum of blue and white stars in the ultraviolet, and of yellow and red stars in the infrared; 4, by taking twice as many readings at each wave length; 5, by observing the same star on several more nights.

We now give as a sample the readings on the star Arcturus at wave length 4710 A. The numbers express the positions on the scale in whole turns and fractions thereof, and the differences caused by shifting the spectrum from one vane of the radiometer to the other.

TABLE 2.—*Sample readings at wave length 4710 A. on Arcturus*

Time	Right vane	Left vane	Deflection	Deviation from mean
$7^h\ 17^m\ 15^s$	41.78	41.07	0.71	11
45				
7 18 30	41.90	41.53	0.37	23
19 00				
7 19 30	41.97	41.78	0.19	41
20 15				
7 20 45	43.29	42.17	1.12	52
21 30				
		Mean........	0.60	0.32

Such mean observations were first multiplied by correcting factors for prismatic dispersion, so as to reduce them to a uniform scale of wave lengths. It was then needful to correct the results for atmospheric transmission, to reduce them to outside the atmosphere. For this purpose all the solar-constant observations of the month of September made at Mount Wilson in the years 1915, 1916, 1917 were considered. From Annals, Astrophysical Observatory, volume 4, table 37, the mean values of atmospheric transmission for September in these three years were computed as follows:

TABLE 3.—*Mean atmospheric transmission*

Wave length	0.35	.40	.45	.50	.60	.70	.80	1.00	1.20	1.60
Transmission	.587	.718	.797	.847	.890	.935	.956	.970	.975	.980

These values were plotted, and values were interpolated at the wave lengths observed in the stellar spectra. Air masses were computed corresponding to the median time of observation of each wave length for each star. From these data factors were computed to reduce all the mean deflections to what they would have been if observed outside the atmosphere.

One other correction was desired to allow for the effect of the imperfect reflection of the numerous mirrors in the optical train. We had intended to determine this by observing the solar spectrum with the identical apparatus, and comparing with the known energy spectrum of the sun. But we were unsuccessful in this experiment on the one afternoon when we could try it. Hence as a substitute we estimated the transmission of the optical train as follows. In a future expedition we intend to observe the solar spectrum very carefully.

Including the telescope and spectroscope there were eight aluminized mirrors in the train. We shall neglect selective absorption and reflection in the two fused-quartz lenses and the prism, thinking that the selective differences, while doubtless not negligible, would be small in these parts within the wave-length range 4230 to 8170 A. All the mirrors were recently aluminized and may be assumed to have the following reflection characteristics:

TABLE 4.—*Factors for optical train*

Wave length	.423	.448	.471	.505	.559	.622	.750	.817
Reflection %	94	94	94	94	93	93	92	92
Eighth power of %....	.61	.61	.61	.61	.56	.56	.51	.51

Owing to the large percentage accidental error of the observations, and our expectation of publishing greatly improved results next year, we do not give here the results for individual stars. We divide the eight stars in groups with regard to spectral class. Moreover, in taking mean values within the groups, we reduce the stars to about equal levels of brightness, by considering their respective magnitudes. Applying these several reductions we arrive at table 5.

TABLE 5.—*Average energy distribution for spectral types, as of outside the atmosphere*

	Energy values for given groups of stars and spectra			
Wave length	Rigel B_8 Sirius A Vega A	Altair A_5 Fomelhaut A_3	Capella G	Arcturus K Aldebaran K_5
.423	336	105	3	99
.448	162	266	35	127
.471	179	72	82	123
.505	69	105	103	159
.559	20	115	73	138
.622	41	82	73	67
.750	...	...	92	49
.817	...	...	86	57

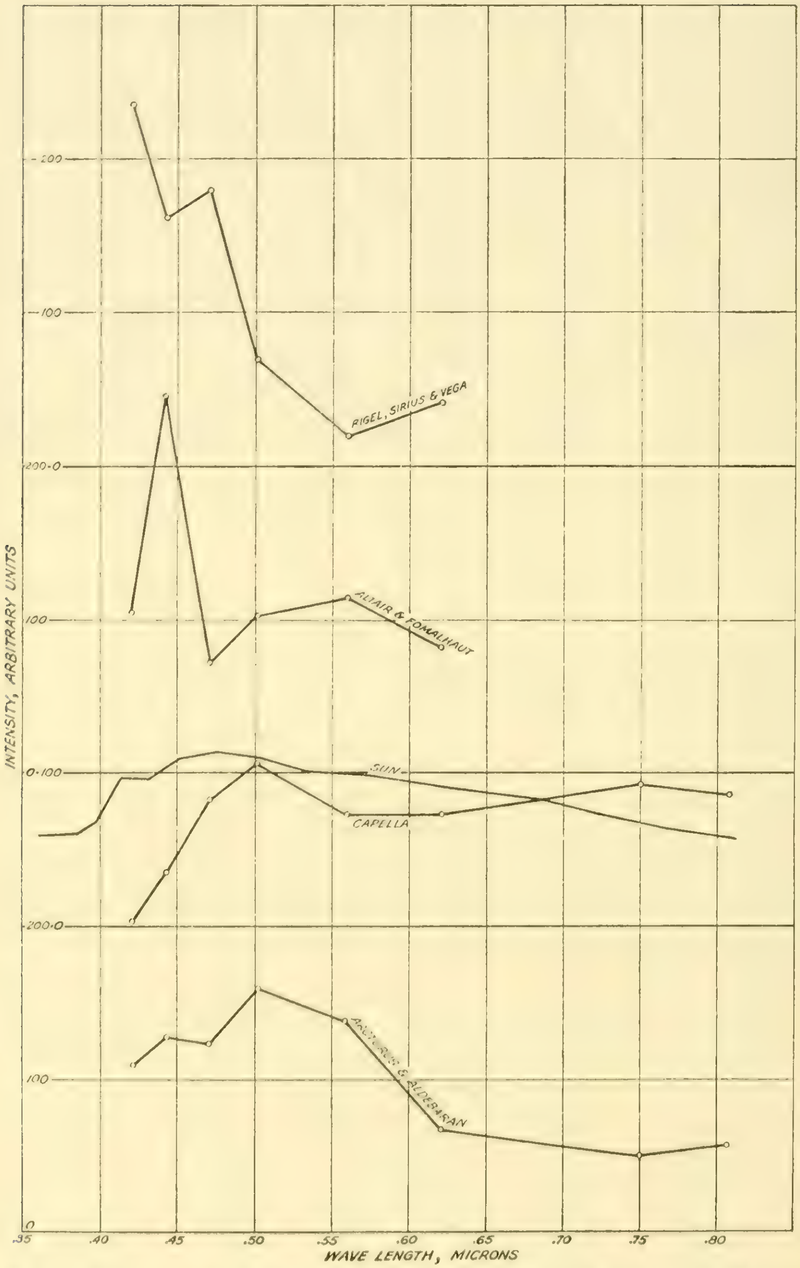
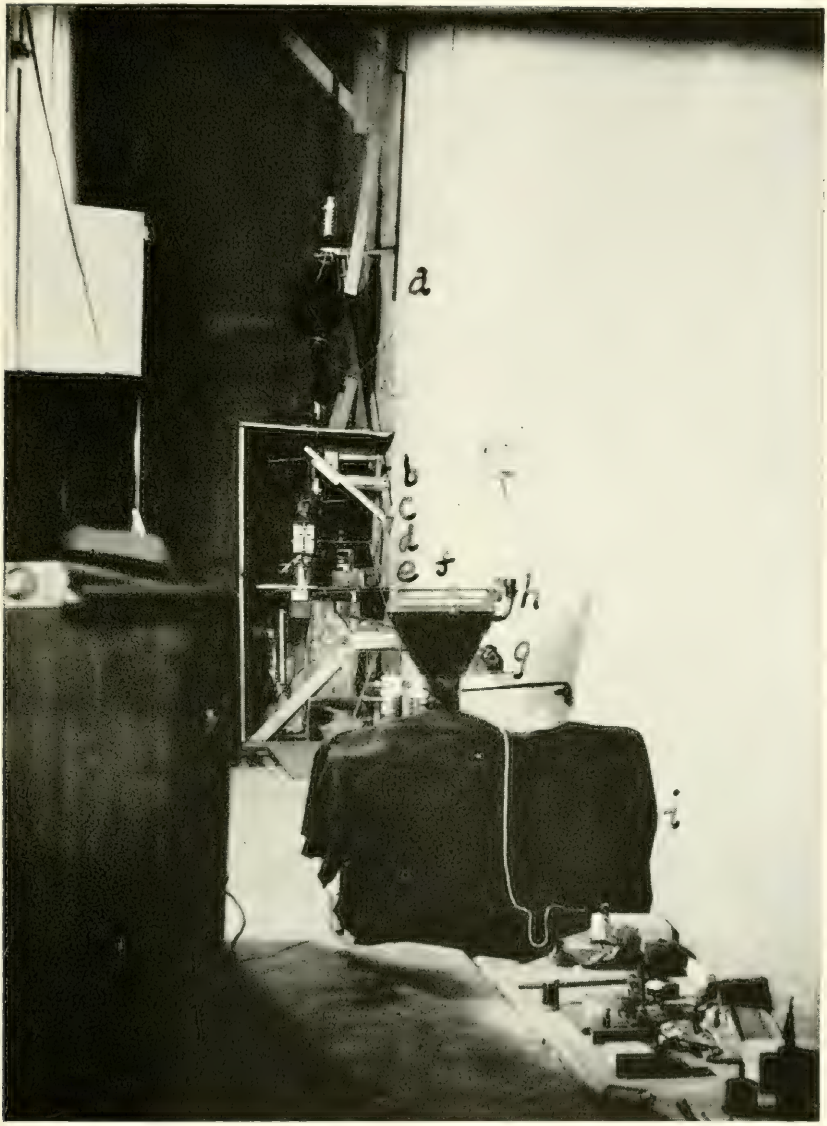


FIG. 3.—Mean curves of prismatic energy and wave length for groups of stars of various spectral classes.

These values are shown graphically in figure 3. That they do not fall in smooth reasonable curves of energy distribution is of course apparent, but is easily understood by recalling that the average deviations of mean values range from 20 down to 7 percent of the maximum ordinates for the individual stars.

Nevertheless the curves show a progressive displacement of the maxima toward the red for advancing spectral types. Moreover the maximum for Capella, probably occurring at a little shorter wave length than 0.505 micron, is close to that of the sun at 0.476, both stars being of spectral type G. As stated above, we regard these tentative results as offering much promise for the proposed expedition of 1948, and still more if it should later be possible to use the 200-inch reflector on Mount Palomar.



General View of the Radiometer Set-up within the Constant-temperature Room of the 100-inch Telescope

At *a* the brilliant Mazda lamp, with tube ending at *b* with pinhole diaphragms at either end of the tube. At *c* a mirror to reflect spectra directly downward through the quartz lens at *d* into the radiometer case at *e*. Opposite *f* are mirrors to reflect the reading beam 5 meters to the scale and reading device *h*. At *g* is the micrometer to set and read spectrum positions. Opposite to *i* is the cord for moving the spectra from one radiometer vane to the other.

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INTRODUCTION

It is well known that some lots of lettuce seed (*Lactuca sativa* L.), under particular environmental conditions, will give a higher percentage germination if exposed to light than if maintained in darkness during the germination test (Larson and Ure, 1924; Shuck, 1933, 1934; Flint, 1934*a*, 1934*b*, 1935, 1936; Flint and McAlister, 1937; Thompson, 1938). This response, which is found also in many other species and has been termed "light-sensitivity," is influenced by several factors including the variety, storage history of the particular seed lot, temperature and water supply during the test, and characteristics of the irradiation treatment. No systematic study of the role of the influential factors has been reported for lettuce seed, and there is very little information as to the mechanism of light-sensitivity in general. One suggested mechanism is that dormancy is caused by the presence in the seed of a growth inhibitor which is somehow rendered inactive by light.

There exists a considerable body of evidence that dormancy of a number of species is controlled, or at least influenced, by chemical inhibitors present in, or formed by, the seed or fruit (for literature citations see Stout and Tolman, 1941; Nutile, 1944, 1945). The presence of such inhibitors in lettuce has been invoked as an explanation for various aspects of dormancy (Borthwick and Robbins, 1928; Shuck, 1934), and evidence for the formation of germination inhibitors by this species has been reported by Shuck (1935) and by Stout and Tolman. Similar evidence, to be published separately, has been obtained by the writer.

Nutile (1944, 1945) discovered that in darkness low concentrations of coumarin prevented germination of lettuce seed under conditions

[1] Now with the Department of the Army, Camp Detrick, Frederick, Md.

favorable to germination in the absence of this compound. Appreciably higher concentrations were required for comparable inhibition if the seeds were illuminated, however.[2] Nutile suggested that coumarin, or related compounds, might occur naturally in lettuce seed and play the role of a germination inhibitor. Coumarin, which itself does not absorb visible radiation, was believed to become photosensitive upon entering the seed.

Two facts have been regarded as furnishing some support for the suggestion of coumarin as an endogenous inhibitor. In the first place the compound is known to occur in a considerable number of plant species (see Nutile, 1945), although its presence in lettuce has not been demonstrated. Secondly, a number of naturally occurring substances having inhibitive effects on cell growth in both plant and animal tissues have been shown to possess an unsaturated lactone structure as does coumarin. Coumarin has been found to inhibit germination and seedling development in several other species also (see Audus and Quastel, 1947), although the effect of light has not been investigated in these.

Nutile's hypothesis thus seems rather attractive, and if substantiated might contribute greatly to solution of the problem of light-sensitivity of seeds.

The present report describes some experiments undertaken with the purpose of ascertaining whether the effect produced by coumarin is specific for this substance or can be duplicated by other compounds more or less similar in molecular structure.

EXPERIMENTATION AND RESULTS

Methods.—All the data herein reported relate to the black-seeded variety Grand Rapids; the seeds were of the 1944 crop and had been in storage approximately 2 years at the time the experiments were

[2] As stated in Nutile's publications, the differential inhibition in light and dark was found when the substrate was moistened with 10 to 100 p.p.m. of coumarin. This is in agreement with our results. In an erratum supplied by Mr. Nutile it is stated, however, that the actual concentrations employed were only one-tenth as great as originally reported. This correction appears to have been made because the solubility of coumarin is sometimes given in the literature (Seidell, 1941; Hodgman, 1944) as 0.01 percent (100 p.p.m.), a value taken from a determination by Dehn (1917); examination of Dehn's paper reveals that the determination was of a very low order of precision. The solubility of coumarin was earlier reported (Schimmel & Co., 1899) as 0.12 percent at 0° C., 0.18 percent at 16-17°, and 0.27 percent at 29-30°; we have found the solubility at 25° to lie between 0.2 and 0.3 percent.

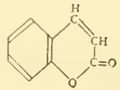
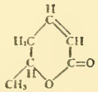
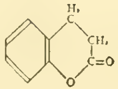
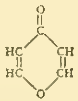
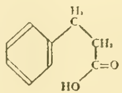
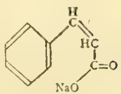
commenced. Seeds of this age were chosen so that there would be no significant change in germinative energy during the period of some months required for the study. Some of the tests were repeated with variety Black-Seeded Simpson, with similar results.

Two series of experiments were conducted. The first was designed to determine approximately the effective concentrations of the various substances and to evaluate the possible influence of variations in temperature, spectral quality and intensity of the light, duration of the germination period, and other details of technique. The general character of the results was found to be the same at temperatures from 16 to 23°, in red light and in white light, and over a hundredfold range of light intensity.

In the second group of tests a finer series of concentrations was compared, all other conditions being kept uniform. Each treatment was carried out in duplicate (100 seeds per dish) and the experiments were repeated one or more times at the critical concentrations. The air-dry seeds were distributed on dry blotters in small Petri dishes, amounts of the solutions slightly greater than required to saturate the blotters were added, and the dishes placed, within a few minutes, under the desired condition of light or darkness which was maintained until observations were made 3 or 4 days later. The water-jacketed thermostat employed as a germinator was provided with several independent compartments so that a number of tests could be made concurrently in light and in darkness without interference. The temperature was maintained at $22.55 \pm 0.05°$ C. Illumination was furnished by a 20-watt red fluorescent lamp 20 cm. above the seeds with a sheet of window glass interposed.

Results.—A number of compounds were found to inhibit germination to a greater extent in darkness than in light; with increasing concentration the germination was progressively less both in light and in dark, the inhibitory effect of a given concentration being always greater in darkness. Data obtained in the present study suggest that the concentration-inhibition curves for various compounds may differ greatly in shape. To assess the relative effectiveness of different substances it would be desirable to determine concentration-inhibition curves for each, so that comparison could be made either among the concentrations required for a given degree of inhibition, or of the effects produced by a selected concentration. A complication arises in experiments of this kind in that it is necessary to distinguish between effects upon the *initiation* of germination and those on *subsequent development* of the seedling. Several substances were found to permit

TABLE 1.—*Effect of several toxic compounds on germination of Grand Rapids lettuce in light and in dark*

Compound	Formula	Concentration		Germination (as % of water control [1])	
		Molar	p.p.m.	In light	In dark
Coumarin		0.0002	29	99	31
Parasorbic acid		.0002	30	98	82
Melilotin		.0005	56	99	78
γ-Pyrone		.001	96	100	84
Sorbic acid	$CH_3-CH=CH-CH=CH-COOH$	.001	112	98	87
Hydrocinnamic acid		.002	300	99	88
Sodium *tr*-cinnamate		.002	340	100	77

[1] At 22.5° the water controls give somewhat greater germination in light than in dark; the averages of 10 experiments (2,000 seeds each in light and in dark) were: light 89.6 percent, dark 84.8 percent. In order to correct for this effect of light itself, the results in the presence of added chemicals have been calculated as percentages of the corresponding light or dark controls.

emergence and some elongation of the root and shoot but then to exert secondary toxic effects upon one or the other organ. A similar observation has been made by Audus and Quastel (1947) in the case of coumarin. As the criterion of germination used in this study is elongation of the seedling axis, a secondary suppression of such elongation, if sufficiently great, renders impossible the accurate determination of the germination percentage.

For this reason it was thought preferable to compare the lowest concentrations (within a twofold range) that showed a significant difference between light and dark. At such concentrations there was no

TABLE 2.—*Effect of several less active compounds on germination of Grand Rapids lettuce in light and in dark*

Compound	Molar concentration	Germination (as % of water control) In light	In dark
Sucrose	0.1	94	12
Maltose	.1	87	48
Lactose	.1	100	29
Glucose	.1	98	57
Fructose	.1	87	21
Galactose	.1	97	39
Mannose	.1	97	32
Arabinose	.15	90	56
Xylose	.15	94	30
Sorbitol	.1	94	45
Mannitol	.1	92	31
Ascorbic acid	.1	96	50
α-Alanine	.1	99	29
β-Alanine	.1	98	32

uncertainty in classifying a seed as germinated or not: a portion of the population showed no macroscopic development at all, while the remainder had radicles at least 4 to 5 mm. long.

In table 1 are listed, in descending order of activity, some compounds which, at approximately the same order of magnitude of concentration, act similarly to coumarin. In table 2 are listed several substances which are much less toxic than the foregoing, but which, in sufficiently high concentration,[3] also cause greater suppression of germination in darkness than in light.

[3] Whether the high osmotic pressure of these solutions is entirely responsible for their inhibitory effect is not known. Stout and Tolman (1941) found that comparable inhibition of New York No. 12 variety of lettuce required concentrations of sodium chloride or sucrose equivalent to 5 or 6 atmospheres.

DISCUSSION

Consideration of the studies of lettuce germination reported in the literature together with results of as yet unpublished experiments of the writer leads to the following view:

Dormancy and germinability of lettuce seed appear to be controlled by a delicately balanced mechanism which is highly sensitive to a diversity of factors. The response of a given lot is influenced both by the integrants of the environment at the time of testing and by the internal condition of the seed, which is determined in part by its history from the time of harvest or even earlier. The precise effect of each of the several operative external and internal elements is dependent upon the concurrent status of all the others.

Light is not essential for germination of lettuce. Depending upon conditions it may or may not be favorable. Germination of all the viable individuals of a given population can occur in darkness provided that the constellation of influential internal and external factors is optimal. When this is not the case, as in freshly harvested seed or at elevated temperature, the suppression of germination which is found in darkness can be overcome to some degree by illumination.

Similarly, light tends to counteract the adverse influence of exogenous chemical germination inhibitors. The foregoing results demonstrate that this behavior is independent of the specific inhibitor. In other words, stimulation by light, which obviously can be manifested only under conditions which are suboptimal for germination, is a general response to such conditions.

The finding that chemical induction of light-sensitivity is not a specific effect of coumarin, or even of compounds possessing similar molecular groupings, would appear to weaken materially, although not necessarily to disprove, the hypothesis that coumarin plays a role in the natural dormancy of lettuce seed.

SUMMARY

It has been proposed that coumarin may be the endogenous germination inhibitor responsible for light-sensitivity of lettuce seed, on the basis of the finding that the inhibitory action of this substance is greater in darkness than in light. In the present paper it is shown that the effect is not specific for coumarin. Other compounds demonstrated to act similarly are parasorbic acid, melilotin, γ-pyrone, sorbic acid, hydrocinnamic acid, sodium *trans*-cinnamate, sucrose, maltose, lactose, glucose, fructose, galactose, mannose, arabinose, xylose, sorbitol, mannitol, ascorbic acid, α-alanine, and β-alanine.

Acknowledgments.—The author is indebted to Dr. Oren Justice and G. E. Nutile for samples of lettuce seed, to Dr. A. P. Swain of the McNeil Laboratories, Inc., for parasorbic acid (δ-hexenolactone), to the Carbide and Carbon Chemicals Corporation for sorbic acid, to R. W. Greeff Co., Inc., for melilotin, and to Miss Lorraine Arkin for assistance with some of the experiments.

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