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MAMMALS OF THE BLACK SEA AND THE SEA OF AZOV

Results of joint biological-commercial dolphin whaling studies.

By S.E. Kleinenberg

UNEDITED TRANSLATION
For information only
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AUTHOR'S PREFACE

The mammalian fauna of the Black Sea and the Sea of Azov is represented by one species of seal and three forms of dolphins. The latter have been objects of industry since ancient times but it was only during the Soviet period that an organized industry began. Beginning with this period, we also began to build up at an intensive rate of our knowledge of the biology of these animals, although it should be noted that the mammals of the Azov-Black Sea basin have been studied since the end of the 18th century. 3*

By now Soviet science has accumulated copious and varied materials on the group of animals we are concerned with. Unfortunately this material is so widely scattered throughout various publications that many

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*Numbers in the right-hand margin indicate the corresponding pages in the original.

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by S.E. Kleinenberg

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very important and interesting papers are known only to a narrow circle of specialists.

The aim of this book is to sum up all of this material and where possible to fill in the missing links in order to provide a biological foundation for the proper organization of the industry and to plan some courses for a rational exploitation of the natural resources of these waters.

In order to achieve this aim we first needed to clarify the taonomic status of the Black and Azov Sea mammals, since up to now this question could not unfortunately be considered settled.

Of course it would not be possible to achieve our aim without studying the ecology of the species of dolphins which inhabit the Azov-Black Sea basin. As the material on these species has built up, it has become increasingly clear that there are quite definite ecological differences among the different species of dolphin which determine the differences in the nature of the distribution, behavior and numbers of the animals in these waters.

These differences compel us to turn to the clarification of the morphological and some of the physiological characteristics of the individual species. It has turned out, as was to be expected, that these characteristics fully correspond to the ecology. It was important to uncover these links and to demonstrate them.

This logical order in drawing on the available material has determined the content and the arrangement of the chapters in this book, which of course, are not all equal in scope. Thus, for example, the section on the taxonomic status of the mammals of the Azov-Black Sea basin appears *4 out of all proportion in comparison to the other sections. This can be explained by the complicated tangle the taxonomists have made of this question for, "unfortunately the freedom with which systematic characters are endowed with one sort of taxonomic significance or other by 'over-enthusiastic' taxonomists who have been carried away by the number of new descriptions, has more than once bordered on blatant caprice" (E.N. Pavlovskii, 1952a, page 172). This set of circumstances compels us to look critically at every attribute put forward by previous researchers as a diagnostic character. This cannot help but affect the length of that particular chapter.

On the other hand in order to reduce the length of the text I have often resorted to the most abridged approach. This applies, for example, to the question of the origin of the Black Sea and the first section of the second chapter. Some general questions relating to the morphology and biology of dolphins are, as it were, put in parenthesis in this section which makes it possible to cut down on any further exposition of the subject and concentrate the attention on the differences which exist between various forms. In the same way the technical side of the commercial whaling of dolphins and the subsequent processing of the raw material are also set out in outline.

In dealing with the research materials and in the course of writing this book I frequently had recourse to the advice and assistance of my teachers and fellow workers as well as of my colleagues at the Ministry of Fisheries and institutions coming under the Ministry. I should like to convey to all of them my sincere thanks.

First and foremost I remember with a warm feeling of gratitude the unforgettable director of the laboratory in which this book was conceived and to a large extent written, Professor S.A. Severtsov. My frequent conversations with him and the lively interest he always showed in commercial animals furnished me with many ideas to mull over with regard to the biological material which I had amassed.

I also had many valuable ideas for the outline and the writing of this book from the late Professor V.V. Vasnetsov and also from Professors B.S. Matveev, S.P. Naumov and V.I. Tsalkin.

I am obliged to A.S. Sokolov and S.L. Delamure for unplubished materials relating to their research which I have used in this book.

In the organizational work involved in producing this book I *5 had a great deal of assistance from the USSR Minister of Fisheries, A. A. Ishkov, from the former chief of the Main Administration of the Azov-Black Sea Fishing Industry, S.P. Emel'yanov, the Director of the Novorossiisk Biological Station, E.I. Drapkin, the Director of the Novorossiisk Fishing-boat Base, G.D. Pichko, the Director of the Yalta Fish Factory, M.P. Kalmykov and the chief of the factory workshop, I.A. Bykovskii.

Without the confidence which the above-mentioned persons showed in me without their help I would never have been able to complete this book.

INTRODUCTION

In the post-revolutionary years quite a bit has been achieved in the study of the fauna of the Black Sea and the Sea of Azov, particularly as regards mammalian fauna. Thus, for example, three times more papers have been published over the last 38 years than through the whole of the 132 years which constitute the pre-revolutionary period of research. *7

To make this clear, I will illustrate the situation by means of a graph (Figure 1) on which the Y-axis sets out the number of papers published (in %), while on the X-axis we see the time, divided into approximately equal sections, beginning from 1785, the year when the first paper devoted to this field appeared.

In Sevastopol in 1871, the first Russian marine biology station was established. This year may be taken as the beginning of the routine study of the Black Sea as can be seen very clearly from the figures given in V. R. Nikitina's bibliographical study (1940). Thus, for example, from 1773 to 1861, that is, over a period of 88 years, the entire output of biological literature on the Black Sea was limited to 22 titles. The subsequent years produced the following figures:

Years	Number of titles
1861-1880	53
1880-1899	123
1899-1917	138
1917-1937	350

However, the pre-revolutionary and post-revolutionary periods of research do not differ only with regard to the number of studies published, but also, which is more important, with regard to the content of the papers involved. Whereas we rightly call the first period the faunal period, on the other hand, we are justified in calling the Soviet period the ecological period, which is, of course, linked with intensive industrial development and hence, with the demands of a practical approach and with the general development of the science of ecology in this country.

Noting the achievements in Soviet ecology over a 20-year period, A.N. Formozov (1937) writes: "Twenty years ago the Cetacea were one of *8 the least studied among our theriofauna. Over this 20-year period a lot was done not only to elucidate the species composition of Cetacea, but also with regard to the detailed study of the ecology of a number of species".

In connection with the Cetacea of the Azov-Black Sea basin, it can be stated that while during the Soviet period of research a few studies also appeared which were of a taxonomic nature, the remaining bulk of the literature appearing during this period relates to ecology.

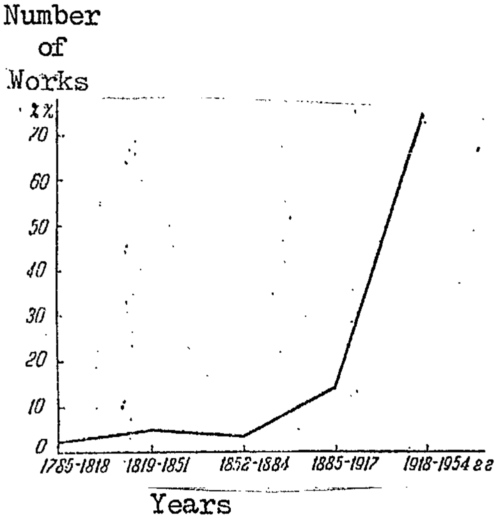

Figure 1. The dynamics of the study of mammals of the Black and Azov Seas.

Speaking of ecology, I feel I must mention the fact that in recent years, many biologists, both Soviet and others have become involved with so-called ecological classifications. On the basis of the ecological characteristics of individual species of animals, they are grouped into ecological types, groups, and so on. Some scientists even classify biotypes and entire biocoenoses in this way.

One would think that such a classification is not the task of present-day ecology since it leads this branch of science into a blind alley. It is a question of classification for the sake of classification. No conclusions of either a theoretical or practical significance emerge from such a classification, apparently due to the fact that it is scarcely possible to make such classifications at all.

It is another matter if it is a question of bringing ecology into the realm of taxonomy or animal morphology. Here, ecology makes it possible not only to establish one or another morphological feature, but to understand and explain its significance for the biology of an animal. But to substitute taxonomy for ecology, setting out ecological types, classes, groups of animals, it seems to me is hopeless, for aside from witty but useless generalizations and inferences, it leads nowhere.

The task of ecology consists in ascertaining the mechanisms of life processes of a species or a population as a whole depending on the conditions of the habitat. Hence, the study of the effects of external conditions on animals; the ascertainment of environmental factors, both favorable and unfavorable to the animals; the examination of the adapta- *9
tion of the animals for exploiting favorable external conditions and adapting to unfavorable ones and consequently, problems regarding the principles of population dynamics of animals arising out of this.

As data accumulated, quite distinct ecological differences among the individual species of Black Sea dolphins began to emerge in ever increasing degrees. These differences between what one would think close forms, inhabiting the very same basin, were of great interest and necessitated the turning of attention to ascertaining morphological and certain physiological features of the individual species.

Taking such a course, we arrived indirectly at the comparative method of research which was so successfully developed by Russian scholars, including A.N. Severtsov. It should be noted that Academician A.N. Severtsov, being a morphologist himself, none the less stressed the necessity of developing the complex ecological-phylogenetic studies. "This method," he wrote, "as we have seen, consists of a critical and as far as possible, a detailed correlation of phylogenetic research data, i.e. data of comparative anatomy, paleontology and comparative embryology with the data of the physiology and biology (ecology) of the groups of animals being studied" (A.N. Severtsov, 1949, v. 5, p. 262).

Our adoption of the comparative method of research with the inclusion of morphological and certain physiological indices permitted us, it seems to me, not only to corroborate on concrete data the correctness of the principle of harmony of the organism and the environment, but also aided in clarifying these differences which are observed in the character of the dispersion and distribution of animals in the basin, in their habits and in their abundance of the individual forms.

* * *

The collection and the processing of the data was begun by me in 1933 and continued with some interruptions (1937, 1940-1945, 1950) until 1952, i.e. on the whole, 12 years.

In the area of taxonomy, I made use of mainly craniological analysis, conducted according to the method proposed by I.I. Barabash-Nikiforov (1938). The only difference was in the number of measurements. Thus, while Barabash-Nikiforov (1940) took 35 measurements on one skull, then I, striving to take all measurements necessary for a more thorough investigation of the configuration of the cranium, took 50 measurements which are presented below. Those which Barabash-Nikiforov took are marked with the letter "a", at the same time, three of the measurements indicated by him, namely: 1) the greatest width of the foramen magnum, 2) its greatest height and 3) the length of the maxillo-premaxillar suture, were not taken by me because these indices are highly subject to individual variability, which was convincingly demonstrated by V.I. Tsalkin (1938). *10

In the area of taxonomy, I confined myself mainly to a craniological analysis because the cranium has the most complex structure, and it is precisely in it that morphological changes, which may not as yet be noticeable in the remainder of the skeleton, primarily occur. It is not without reason therefore, that it is the cranium that is the most reliable and most widely used material in the taxonomy of all mammals. Moreover, all of the previous researchers also made use of craniological analysis. The data necessary for comparison was contained precisely in this analysis and every new feature that I proposed would have hung in mid air, for there would have been nothing to compare it with. The above considerations are what determined the measurements below.

LIST OF CRANIAL MEASUREMENTS

a. 1. Overall length of the cranium (corresponding to the condylobasal length in the cetaceans) - from the posterior margin of the occipital condyles to the end of the rostrum.

a. 2. Basic length of the cranium - from the middle of the inferior margin of the foramen magnum to the end of the rostrum.

a. 3. Length of the rostrum - from the lines of the maxillary notches to the end of the rostrum.

a. 4. Length of the alveolar row of the maxilla - from the posterior margin of the alveolus of the last tooth to the end of the rostrum. (on the left side).

a. 5. Maximium breadth of the cranium - the distance between the most prominent lateral points of the posterior part of the cranium.

a. 6. Interorbital breadth - at the narrowest point of the interorbital interstice.

a. 7. Maximum breadth of braincase - the distance between the centers of the temporo-parietal fossae.

a. 8. Maximum height of the cranium - the distance between the most prominent superior and inferior points of the posterior portion of the cranium.

a. 9. Width of the rostrum at the base - along a line of the maxillary notches.

a. 10. Width of the rostrum at the last tooth - along a line of the last tooth of the maxilla.

a. 11. Height of the rostrum at the last tooth - a vertical measurement in the position of the last measurement.

a. 12. Width of the rostrum at midlength - along a line, bisecting the length of the rostrum.

a. 13. Premaxillary width at rostral midlength- along a line of the preceding measurement. *11

a. 14. Length of the premaxillaries - the greatest.

a. 15. Length of the basilar process - from the inferior margin of the foramen magnum to the farthest point on the border of the vomer.

a. 16. Length of the facial section - from the anterior margin of the notch of the external nares to the end of the rostrum.

a. 17. Length of cerebral section - (obtained by subtracting the value of measurement 16 from value of measurement 1).

a. 18. Height of occipital area - the greatest: from the inferior margins of the occipital condyles to the highest point of the occiptal crest.

a. 19. Condylar width - the largest diameter of the occipital condyles.

a. 20. Condylar height - distance between the superior and inferior margins of the occipital condyles.

a. 21. Width of the premaxillary bifuraction - the greatest: the distance between the inferior edges of these bones in the area of the external nares.

a. 22. Lateral diameter of the external nares - the greatest.

a. 23. Distance between the anterior margin of the notch of the external nares and a line of the maxillary notches (obtained by subtracting the value of measurement 3 from the value of measurement 16).

24. Distance from the inferior margin of the foramen magnum to the pterygoids along the median line.

25. Distance from the inferior margin of the foramen magnum to the posterior margin of the alveolar row along a median line.

26. Maximum breadth of the cranium in the anterior portion of the frons - the distance between the most prominent lateral points of the margins of the frontals.

27. Distance from the occipital crest to the end of the rostrum along a median line.

28. Distance from the superior interstice between the nasal bones to the end of the rostrum.

29. Distance from the anterior margin of the temporal fossa to the anterior margin of the frontals - on the left side.

30. Width of the pterygoid foramen.

31. Length of the pterygoid foramen.

a. 32. The greatest length of the temporo-parietal fossa - on the left side of the cranium.

a. 33. The maximum height of the temporo-parietal fossa- on the left side of the cranium.

34. Length of the occipital crest - in a straight line.

35. Length of the occiptal crest - with a tape.

36. Diagonal - from the inferior margin of the foramen magnum to the posterior margin of the zygomatic arch of the temporal (on the left side of the cranium).

37. Diagonal - from the center of the pterygoids to the anterior edge of the zygomatic arch of the temporal (on the left side of the cranium). *12

a. 38. Length of tooth at midlength of the maxilla - on the left side.

a. 39. Width of tooth - in the same area.

a. 40. Frequency of teeth in a 2.5 cm length in the maxilla - in the same area.

a. 41. Number of teeth in each jaw on both sides.

a. 42. Length of mandible - from the posterior edge of the mandibular condyles to the anterior tip of the mandible (on the left side).

a. 43. Length of the alveolar row of the mandible - from the posterior margin of the alveolus of the last tooth to the end of the jaw (on both sides.)

a. 44. Width of the base of the mandible - the distance between the most prominent points of the processes at the base of the jaw (on the left side).

45. Distance from the notch at the mandibular condyle of the mandible to the end (on the left side).

46. Distance from the posterior edge of the mandibular condyle to the posterior margin of the alveolar row of the mandible (on the left side).

47. Distance from the posterior edge of the mandibular condyle to the posterior margin of the notch on the interior side of the mandible (on left side).

48. The smallest height of the mandible (on left side).

a. 49. Height of the mandible behind the last back teeth (on the left side).

50. Length of symphysis.

It is understood that all of the measurements with the exception of the 35th were taken with sliding calipers.

The side of the cranium on which one or the other measurement was taken is not indicated incidentally. This is explained by the asymmetry of the cranium, characteristic of toothed cetaceans.

In addition to the measurements indicated here, I attempted to use two more values: the weight of the cranium and the weight of the _bulla tympani_. Nothing came of it, however. The point is that the cranium of the dolphin, as does the entire skeleton, contains much fat. Thus, the weight of the cranium is determined not only by the weight of the bone mass, but by a degree of decoction of the cranium as well. Moreover, as a result of hygroscopicity of the bones, their weight fluctuates intensely depending upon the humidity of the atmosphere.

Besides the craniological measurements, I used other indices employed by previous researchers: namely, the body measurement of the animals and the nature of the color.

Of the indices employed by taxonomists, I excluded completely only *13 the body proportions because of the fact that before me was the task of determining how competent the establishment of the Azov and Black Sea dolphins into independent species and subspecies done by preceding researchers was. It is quite evident that in order to solve that problem, a comparison of data on Cetacea of the basin under consideration with data on the same species from other water bodies is necessary first of all. In addition to that, the most reliable data contained in publications by foreign authors is on skull proportions, including linear measurements of animals and their color. There is almost no data on body proportions. Because of this situation I was forced to forgo entirely the measurements of body proportions of animals.

The collection of data which formed the basis of chapter two began back in 1933 when I had occasion to be a participant in an expedition on the study of the mammals of the Black Sea. Since its findings were not published, it is necessary to say even if a few words about it.

The expedition was organized by VNIRO (All-Union Scientific Research Institute of Fisheries and Oceanography) (Moscow) in conjunction with the Scientific Commercial Fisheries and Biological Station of Georgia (Batumi) in 1933. Data was gathered at the permanent observation stations in Batumi, Novii Afon, Pitsunda and Yalta till 1934, inclusively.

The expedition consisted of: S. Yu. Freiman on whom the entire administration of the operations and studies of dolphin migration rested; I. I. Barabash-Nikiforov, who was engaged in taxonomy; G. E. Nikol'skii, studying the reproduction of wild animals and author of those paragraphs who studied the feeding and fatness of dolphins. D. G. Berucheshvili and L. E. Tsuladze (Georgian Commercial Fishing Station), I. F. Tryuber (VNIRO), N. I. Sidorov Azcherniro (Azov-Black Sea Scientific Research Institute of Sea Fisheries and Oceanography) and students of the Moscow State University, F. F. Tsentilovich and A. S. Narkhov, worked as observers on the expedition.

After the expedition, my assistants in conducting operations were the following co-workers from Azcherniro; in 1939 - M. M. Bakshitskii and L. G. Levchenko; in 1946 - A. A. Bykowski and V. A. Bandurenko, in addition to which the former continued to work with me till 1948, inclusively. In 1949, G. E. Feldman participated in the field operations.

* * *

The procedure for the collection and processing of the data used in studying the feeding and fatness of dolphins, I had already set out in detail back in 1940. Stomach contents of animals were used as material for the study of nutrition. Identification was made on the basis of otoliths or on representative cranial bones of fish remaining in the stomach. *14 This procedure was used previously by M. I. Tikhii (1912) while studying nutrition of beluga, and M. M. Ivanov (1936) while studying the Baikal seal.

In identifying the material, besides the works of V. K. Sovinskii (1894), K. Milashevich (1916), N. M. Knipovich (1923), E. Higgins (1868),

E. Koken (1891), Th. Scott (1906) and others, a collection of otoliths of Black Sea fishes prepared especially for this purpose was also used.

For the quantitative nature of feeding, it was decided to go the route of counting the individual specimens and subsequently, very approximately of course, converting the figures into weight indices using the mean weight of the specimens. The application of the procedure developed by hydrobiologists (Data on the Feeding of Fish in the Barents Sea (1931), A. A. Shorygin (1952), et al.) for the study of feeding in fish, i.e. the methodology for determining the total and partial indices of fullness was unsuccessful; first of all, because the food in the stomachs of toothed cetaceans in the majority of cases is highly digested, and secondly, because it is not always possible to determine the weight of every animal under the usual conditions of haste in dressing wild animals.

Under the term fatness condition I have in mind strictly fatness, and not of the entire organism of the animal, but only the relative amount of subcutaneous fat layer. Therefore the fatness coefficient is called the ratio of the subcutaneous blubber (together with the skin, which is called a <u>khorovina</u> by those in the industry) to the weight of the carcass of the animal.

The thickness of the fat layer was measured in a specific, and always in the same spot; namely, after cutting the skin with the fat directly in front of the dorsal fin.

While studying the distribution of the dolphins in the basin, I used published aerial reconnaissance data, personal observations made during many voyages with commercial whaling crews, and finally, data of 1947, collected during a voyage on an <u>Azcherniro</u> vessel in the north eastern region of the Black Sea.

Results of the analyses of the reproductive systems of the animals and watching for the appearance of new-born in the catches, including the observation of the behaviour of dolphins in the sea were used in the clarification of the biology of reproduction.

It will become necessary to dwell in more detail on the operational procedures in the area of the morphological and physiological characteristics of the various species of dolphin (Chapter Three). I was successful in attracting P. A. Korzhuev, who agreed to conduct hematological research, to the studies begun in 1948 in Yalta. *15

It was quite evident that in conducting these studies, laboratory conditions were already required. Therefore, right here on this commercial enterprise, assisted by the administration of the Yalta fish processing factory, a small laboratory was equipped in a short time including electrical service which not only provided lighting, but permitted the simultaneous connection of a centrifuge, a Farburg apparatus and other devices.

Since the results of the research on dolphin blood have already been published by Korzhuev and N. N. Bulatova (1951, 1952), it would be inexpedient to dwell on the procedures of their work here. Therefore, I will discuss the methodologies only of those studies which rested directly with me; namely, the determination of the weight indices of the internal organs of dolphins and gas exchange. We will begin with the obtaining of weight indices.

Besides the absolute necessity here of accuracy in weighing the animal and its internal organs, I became convinced during the course of the study that the time of research has great significance. If the animal was killed long before and has lain dead even 12 hours, the weight indices of the internal organs are different from those of one that has just been killed. This situation forced us to select for weighing only those dolphins without any wounds, i.e. which retained all of their blood, therby ensuring an accurate determination of the weight of the animal. After weighing, the animal was killed and immediately skinned together with the fat layer. Due to the speed with which the latter operation was conducted, I had the opportunity to dissect animals so fresh that often peristalsis in their intestine was going on. Such a method ensured the obtainment of stable, reliable data on the weight of the various internal organs.

Certain purely methodological errors, which will be discussed in the third chapter, forced us to forgo the comparison of the indices of the internal organs of the dolphins with like ones in other animals presented in the literature. For the same reasons, I did not consider it methodologically correct to compare the indices that I obtained with like ones for whales in which, due to the gigantic measurements of the animals themselves, the determination of the values of the indices one has to recognize as more than approximate. Singular data, where the indices were determined according to a procedure close to ours, belongs to A. S. Sokolov. These data, so kindly given to me by the author, are therefore presented in the third chapter.

The determination of the capacity of the lung tissue in the various species of dolphin was very interesting, nevertheless it became necessary to drop the experimental determination of the capacity of the *16 lung tissue for two reasons: the lungs of the common dolphin (Delphinus delphis ponticus) are affected with skryabinaliosis[1] (see below) which

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[1] Trans. note: An infestation of the pulmonary organs with the nematode Skryabinalius cryptocephalus which ultimately destroys the lung tissue and related structures. It is discussed in more detail later in the book.

destroys the tissues; secondly, the lungs in the dolphin, because of the peculiarity in the structure of that organ in the Cetacea (see second chapter), do not collapse after the death of the animals as in terrestial animals and always contain a certain amount of air, to get rid of which without destroying the lungs proved to be impossible.

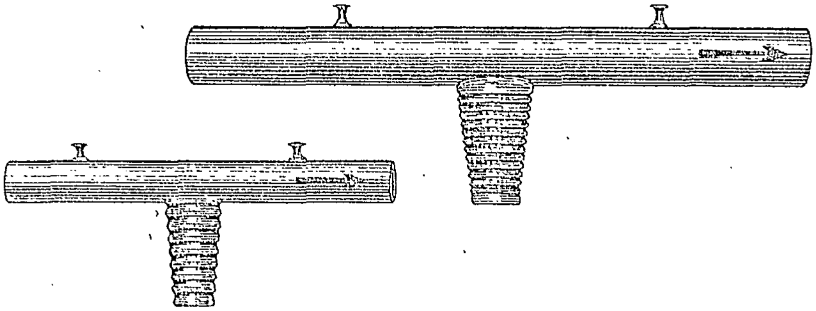

Рис. 2. Тройники для получения воздуха, выдыхаемого животными.

Figure 2. A tee for obtaining air, exhaled by the animals.

The situation concerning the procedure for obtaining data on gas exchange was significantly more complicated. The complexity resulted first of all from the fact that we were the first ones to conduct studies of such a nature on cetaceans. In addition to the above, I considered that it is precisely in the physiology of respiration that there should first of all be differences, conditioned by the ecological peculiarities of the separate species. This caused an urgent search for a means of obtaining such data. The main difficulty lay in the procedure of obtaining the air from a freely breathing animal. For this purpose, a tee with a system of valves was constructed which permitted the collection of air exhaled by the animal and at the same time making it possible for it to breathe atmospheric air. The part of the tee which entered the blowhole was made in the form of a threaded cone in order that the tee may be squeezed as tightly as possible by the tissues of the blowhole. Since the diameter of the latter is considerably larger in the bottle-nose dolphin (Tursiops truncatus) than in other dolphins, two tees were made, depicted in Fig. 2. The arrows denote the direction of the movement of air. The valves which regulate this direction upon exhalation and inhalation are inside the elbows of the tee.

The tee was inserted into the blowhole of the animal; a Douglas sac, in which all of the air exhaled by the animal is collected, is attached to the appropriate tee, as is depicted in the photograph (Fig. 3). *18 After the expiration of a fixed period of time reckoned according to a stopwatch, the air from the sac was passed through the usual hydroscopes, gas meters, determining its volume. A small sample of air ($0.75\ cm^3$) was put into a gas collector for a later analysis of its chemical composition in a Holden apparatus, a model of which containing a $10\ cm^3$ buret, was assembled in a flat case convenient for use in expeditionary conditions. In this way, the Douglas-Holden method, well-known in physiology, was employed in the long run.

It should be noted that it turned out to be rather simple obtaining air from an animal out of the water. After an initial violent reaction upon insertion of the tee into the blowhole, the animal gradually became accustomed to it, settled down and began to breathe calmly. This is exactly when the Douglas sack was attached to the tee. It was considerably more complicated obtaining air from an animal in the sea. Here the reaction upon insertion of the tee into the blowhole was extremely violent and prolonged. Because of this, it became necessary to place the animals into a special tank, for which salting vats were used.

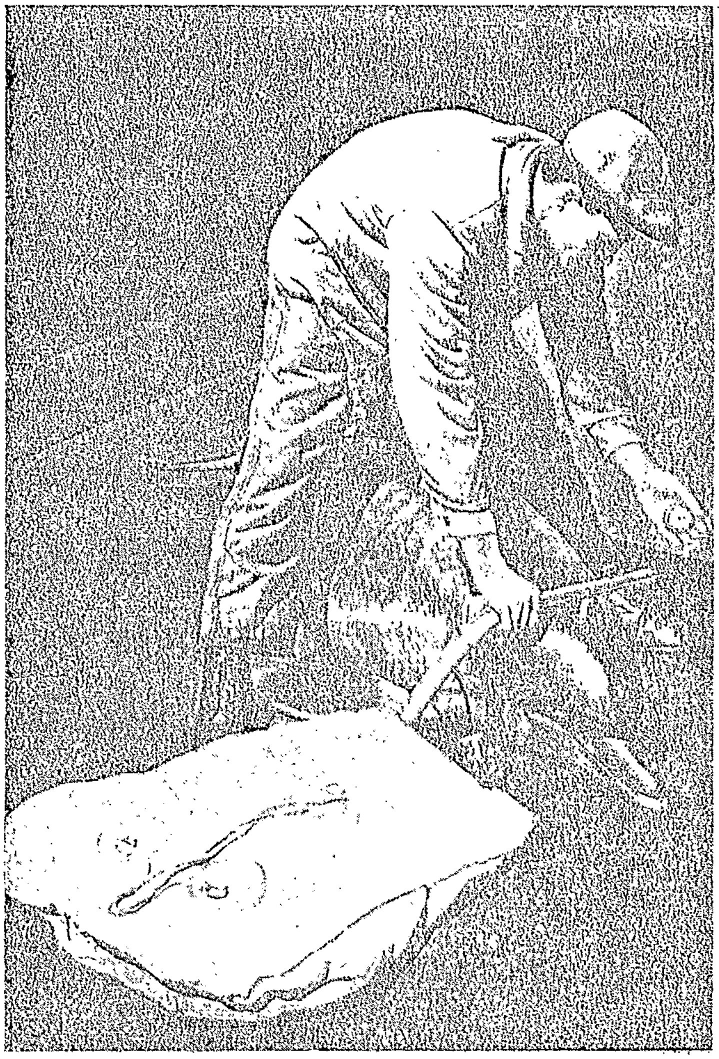

Рис. 3. Получение воздуха, выдыхаемого животным.

Figure 3. Obtaining air exhaled by the animal.

We were succcessful in conducting gas exchange studies on two of the most divergent species: the common dolphin (Delphinus) and the bottlenose dolphin (Tursiops). Unfortunately, we were unable to do the same studies on the harbour porpoise (Phocaena).

The data on the estimation of the condition of the stocks of dolphin in the sea (fourth chapter) requires no description of its collection procedures. Here, the requirement was to collect ovaries of the animals in the largest quantities possible. During their collection, the length of the body of the animal was measured and the reproductive system was examined. Next the ovaries were excised; a small incision with a scalpel was made on the dextral one. The ovaries were tied in pairs, labelled and fixed in Formalin or in a Bouin[1] fixative.

The processing of this material, with the exception of a careful count of the corpora lutea scars of previous pregnancies, did not require any special procedure.

The concluding chapter requires no description of the operational procedures at all.

Turning to the nature of the collected material, it should be noted first of all that the greatest amount is related to the main commercial species - the common dolphin; the remaining species of dolphin of the Black and Azov Seas are represented by a considerably smaller amount of material.

In the area of taxonomy, the data is characterized by the following figures.

Pertaining to the common dolphin, 52 craniums were processed, among them, 44 from the VNIRO collection, 5 from our collections (Zoological Museum of Moscow State University), and 3 craniums from the collection of the Zoological Museum of the USSR Academy of Sciences.

To the data pertaining to the bottle-nose dolphin, 62 skulls were processed, among them, 50 skulls from our collections preserved in the Zoological Museum of MSU and 12 skulls from the VNIRO collection. *19

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[1] Trans. note: Conjectural transliteration.

On the data pertaining to the harbour porpoise, 22 craniums in all were processed; among them, 10 each from our collections, preserved in the Zoological Museum of MSU and from the Museum collection itself, and 2 craniums from the collection of the USSR Academy of Sciences Museum.

In addition, within the collection of the USSR Academy of Sciences Zoological Museum, 8 craniums of some species of dolphin from other bodies of water in which we were interested, were processed.

Thus, 144 craniums in all were processed. The results of the measurements in absolute figures are given in an appendix.

From the figures presented above, it is evident that the bulk of the material on the common dolphin was formed by the VNIRO collection gathered in an expedition which was discussed earlier. It is this very collection that Barabash-Nikiforov (1938, 1940), Tryuber (1937, 1939) and other researchers spent most of their time working.

Data for the study of feeding and fatness of dolphins was collected, as has already been noted back in 1933. Nevertheless, work in this trend did not stop even in succeeding years. During the years 1933, 1934, and partially in 1935, as was already mentioned (S.E. Kleinenberg, 1940), the contents of over 10 thousand stomachs of the common dolphin were collected in Yalta, Novorossiisk, Novii Afon and Batumi. During 1946, in Yalta, Anapa and Cape Utrish, about 3 thousand stomachs of this dolphin were examined, and throughout the year 1948, the contents of 2000 stomachs were examined in Yalta and Novorossiisk. Thus, for the character of feeding in the common dolphin I made use of the data of over 15 thousand individuals from the various regions of the sea.

During 1933, 1934, and in part, 1938, 182 stomachs of the bottlenose were collected in Yalta, and in the same place in 1948, another 50 stomachs which makes 232 stomachs in all.

The harbour porpoise is represented by the least data. In 1934 in Batumi, the contents of 21 stomachs were collected and in 1949 in Anapa, material from 50 animals. I did not use any data from the Sea of Azov.

In the study of fatness of the common dolphin, mainly weight data were used. This was obtained from the data of weigh-masters on fishing operations and collected in the same years and in the same places as the data on feeding. The amount of this data is very great - 70 thousand specimens. Considerably less data on the measurement of the thickness of the fat layer (from 8688 animals) was collected in 1934 in Yalta.

Data on the biology of reproduction in the common dolphin was collected mainly in 1939 and 1946 when in Yalta, Anapa, Cape Utrish, Novorossiisk and Tuapse, the reproductive systems of 4253 animals were examined. In 1948 in Yalta, the reproductive sustems of 50 bottlenoses *20
and in 1949 in Anapa and Novorossiisk, the reproductive systems of 50 harbour porpoises were examined.

A considerably lesser quantity of data was gathered for the study of the morphological and physiological characteristics of the various species of dolphins. This situation is explained first of all by the fact that this material was collected only during two seasons and at two points; secondly, the labor-consuming aspect of the collection. *21

Data on the weight indices of internal organs of the common dolphin were collected from 100 adult specimens (50 in the spring and 50 in the fall), and also from 15 embryos and from 12 underyearlings and yearlings; on the bottlenose and harbour porpoise- from 50 adult specimens of each species in the spring. Of the first two species, the material was collected in 1948 in Yalta; for the harbour porpoise, in 1949 in Anapa and Novorossiisk.

Table 1

Quantity of material used

Таблица 1

Quantity of material employed.

Количество использованного материала

1. Главы, в которых использован материал	2. Наименование материала	3 Количество 4 белобочка	5 афалина	6 азовка	7 Годы сбора	8 Regions of collection Районы сбора
9) I	skull. Черепа[1]	52	62	22	1948, 1949, 1951	a Ялта, Анапа
10) II	Stomach contents Содержимое желудков	15 000	232	71	1933, 1934, 1935, 1946, 1948, 1949	b Ялта, мыс Утриш, Анапа, Новороссийск, Новый Афон. Батуми
11)	[illegible] material on Весовой материал по упитанности [illegible]	70 000	—	—	Те же	c. Те же
12)	[illegible] of blubber Измерения толщины жирового слоя [illegible]	8 668	—	—	1934	d. Ялта
13)	[illegible] reproduction Материал по размножению (половая система) [illegible]	4 253	50	50	1939, 1946, 1948, 1949	e Ялта, Анапа, мыс Утриш, Новороссийск, Туапсе
14) III	[illegible] of the Весовые индексы внутренних органов [illegible]	100	50	50	1948, 1949	f Ялта, Анапа, Новороссийск
15)	Материал по газообмену [illegible]	20	20	—	1948	g. Ялта
16) IV	Яичники [illegible]	2 202	—	—	1939, 1946	h Ялта, Анапа, мыс Утриш, Новороссийск, Туапсе

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[1] В том числе: наши сборы — 65; коллекции: ВНИРО — 56; Зоомузея МГУ — 10; Зоомузея АН СССР — 5 экземпляров.

Key to Table 1:

1. Chapter in which data is used. 2) Name of data. 3) Quantity . 4) Common dolphin 5) Bottle-nose dolphin 6) Harbour porpoise 7) Years of collection 8) Regions of collection 8a) Yalta, Anapa 8b) Yalta, Cape Utrish, Anapa, Novorossiisk, Novii Afon, Batumi 8c) Same as 8b 8d) Yalta 8e) Yalta, Anapa, Cape Utrish, Novorissiisk, Tuapse 8f) Yalta, Anapa, Novorissiisk 8g) Yalta 8h) Yalta, Anapa, Cape Utrish, Novorissiisk, Tuapse 9) Craniums[1] 10) Stomach contents 11) Weight data on fatness 12) Measurements of fat layer thickness 13) Data on reproduction (reproductive system 14) Weight indices of internal organs 15) Data on gas exchange 16) Ovaries

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[1] Including: our collections - 65; VNIRO collection - 56; MSU Zoological Musuem - 10; USSR Academy of Sciences Zoological Musuem - 5 specimens

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Gas exchange studies were conducted in 1948 in Yalta on 20 common dolphin and 20 bottlenoses.

The presented list characterizes in brief the basic material which I employed and is tabulated in Table 1 for a clearer demonstration.

The Table does not reflect all of the material used. Thus, for example, it does not include data on the distribution of the dolphins in the basin, and also, some isolated observations so kindly reported to me by many persons that I am always mentioning in the text. Finally, many of my own observations as well, made during the course of my work and which cannot be expressed in figures, did not enter into the Table.

CHAPTER I

MAMMALIAN FAUNA OF THE BLACK AND AZOV SEAS

1. HISTORY OF FAUNISTIC RESEARCH

We are indebted to our native researchers for the accumulation of knowledge concerning the mammals of the Azov-Black Sea basin. *22

Unfortunately, a tendency towards ignoring the achievments of our science is still being manifested in certain foreign bulletins up until the present time. In oceanographic studies, the works of the Swedish zoologist S. Ekman (1935) and the American bulletin by Sverdrup, M. Jonson and R. Fleming can serve as clear examples of such silence, as L.A. Zenkevich rightly noted (1948).

Meanwhile, it is known that "as a result of many years of thorough research, some of the Soviet seas can be considered as the best studied bodies of water in the world at the present time," (L.A. Zenkevich, 1948, p. 170).

The beginning of studies into the mammalian fauna of the Black and Azov Seas dates back to the end of the 18th century. As long ago as 1785, a work by K. Hablizl "A Physical Description of the Taurian[1] Region According to Its Location and All Three Natural Kingdoms," was published in Russian without indication of the author's surname. Later this work was published in a German translation with the author's name being indicated (K. Hablizl, 1789). This circumstance must be noted because of the fact that many quote the German translation of this work

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[1] Trans. note: According to the Great Soviet Encyclopedia, Taurica was originally the name given to the southern part of the Crimea. In fact, maps of the Ancient Roman Empires refer to the Crimean Peninsula as Taurica Khersonese. Later, according to the Gr. Sov. Enc., Taurica was applied to the entire of the Crimean Peninsula. So, I presume that here Hablizl is using Tauria to refer to the Crimean Peninsula as well.

as the primary source when in fact the primary source appeard in Russian literature.

In this work, the following is written concerning the group of animals under discussion:

"16). Sea pigs.[1] _Mar._ _suin_ (_Delphinus phocaena_ Linn.) The porous, porpoise.

In the Black and Azov seas, and especially in Enikal'skii Straits, in superior numbers, where they often appear on the surface of the water in entire schools, and are of superior size: for often they are more than a _sazhen_[2] in length. However, they are also found in all of the other European seas and are considerably well known," (p. 168). *23

Further:

"17). Seals. _Vecium_ _marin_ (_Phoca_ _vitulina_) common seal. In the Black and Azov Seas; but rarely show themselves near the shores, with the exception of the Sevastopol harbour, where compared to other places, they are more often noted," (p. 169).

Thus, Hablizl indicates two species of mammals for the Black and Azov Seas: the sea pig and the common seal or _nerpa_[3]. The author's note regarding the "superior size" of the sea pig, which has comparatively small body measurements, offers grounds for assuming that Hablizl observed, evidently, yet another species of dolphin actually characterized by large body measurements, but indicated for the Black Sea considerably later.

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[1] Trans. note: Colloquial name for porpoise.

[2] Trans note: An obsolete unit of length equalling 2.134 meters.

[3] Trans. note: According to W. E. Ricker, Russian English Dictionary. Bull. 183, Fisheries Research Board of Canada, Ottawa, 1973 - any small seal. According to the Great Soviet Encyclopedia, this common name applies only to the genus _Phoca_.

A later paper, also published in Russian, belongs to A. Meier (1794). In literature, citations of that work as in Hablizl's work, are not made with reference to the author but; the title, but V. Ul'yanin (1871), quoting it, writes: "published by A. Meier". While such references to Hablizl's paper are justified by the fact that the name of the author was not indicated, then for Meier's work, this is explained by simple misunderstanding. The title of the work itself: "Narrative, geodetic and a natural historic description of the Ochakov lands, contained in two dispatches and composed by Andrei Meier, Liuetenant-Colonel Kherson Granadier Regiment, and member of three scientific societies in Russia," sufficiently clearly indicates that.

In this paper, it is also indicated that of the marine mammals in the Black Sea there can be found "the sea pig; in Turkish - domus-baluk; in French - le marsouin, Delphinus phocaena," (p. 200). It is noted, incidentally, that in October these "sea pigs" pursue schools of mackerel.

Foreign scientists, travelling throughout the Crimea and the Caucasus, for example G. Reulli (1806), M. Engelhardt and F. Parrot (1815), R. Layll (1825), did not report any significant information in our area of interest. The history of the fishing industry near the northern shores of the Black Sea by the archeologist K. Koehler (1832), is to a greater degree of historical-philological interest. And only the voluminous work by I. Georgi (1802), even though it is a compilation of Hablizl's, Meier's and P. Pallas' data deserves at least passing mention.

I. Georgi names the same two species of mammals for the Black and Azov Seas that Hablizl had indicated before him, and namely: the dolphin-sea pig and the common seal. The author divides the latter species into *24 four subspecies: the Baltic, Caspian, the oceanic and Siberian (having in mind, obviously, the Baikal seal), while the Black Sea seal is relegated to the Baltic subspecies by the author entirely without basis (p.1496). Georgi states, incidentally, that the seals in the Black Sea are game animals but not a commercial species for they are killed here singly, and adds that the seals occurring near the coasts of the Crimea are always small in size.

The author does not bring forward any reasons for combining the Black Sea and the Baltic seals into one "subspecies." It is doubtful whether he had any bases for such a unification. It is significant that Georgi, as nevertheless did some of the subsequent authors, speaks of the Caspian and Baikal "subspecies" of the common seal when both Caspian and the Baikal seals were described by Gmelin as species in 1788 - over 14 years before the appearance of Georgi's last volume of works.

The information presented here exhausts the data in the area of the mammalian fauna of the Azov-Black Sea basin which had accumulated in the literature to the time of the appearance of a comprehensive work by the Petersburg Academician P.S. Pallas (1811), and the one considered to be the primary source in Russian zoology.

It is precisely this work published in Petersburg in Latin that many consider as the first stage in the study of the Black Sea fauna. Earlier sources are presented here not only to show the inaccuracy of such a notion and not only because these works are of interest in themselves, but in order to show that this first "pre-Pallas" period of research into the fauna of the Black Sea belongs entirely to our native literature as well.

Pallas names species for the Black and Azov Seas established before him. Thus, citing the same Russian name - sea pig - for Delphinus phocaena, Pallas writes that it often occurs in the Baltic, Black and Azov (Maeotitic Marsh)[1] Seas and is also distributed in the Pacific Ocean (v. I, p. 284). Regarding the common seal, Pallas writes: "the common Phoca canina or vitulina, even though according to Pliny's observations, it does not resemble a calf (vitulina) by voice at all, is very abundant in all of the seas: the Baltic, North, White, Black or Pontic[2], the Arctic and Pacific Oceans, and amazingly (et mirum!), even in fresh-water lakes of Siberia - Baikal and Orona, removed for thousands *25 of miles from the sea... abundant even in landlocked seas without outlets: the Caspian and the Aral, where it was brought by some unknown force in deep antiquity..." (v. I, p. 115). Besides these two species, Pallas names also the monk seal (Phoca monacha) which in his opinion, comes here from the Mediterranean Sea. As a result, Pallas already establishes three mammals in the Black Sea: one species of dolphin and two species of seal.

As we see, Pallas, in the same manner as Hablizl and Georgi, disregards the description of the Caspian and Baikal seals done by Gmelin and takes these two species for one - the common seal, into whose range Pallas clearly inaccurately includes even the Aral Sea.

One circumstance evokes even greater amazement. The most numerous species of Black Sea dolphin, namely the common dolphin or "white-sided" dolphin (Delphinus delphis L.) was not recorded by anyone to Pallas' time. Not only was it omitted by him (as was yet another species),

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[1] Trans. note: Again, the Sea of Azov appears on the map of the Roman Empire as Palus Maeotis, i.e. the Maeotis "Marsh", from L. palus=marsh.

[2] Trans. note: Here, the author is presumably referring to the Pontus Euxinus, an earlier name for the Black Sea.

but its presence in the Black Sea Pallas denied in general. Thus, citing its Russian name "vorvon," Pallas writes: "Often occurs in the Baltic Sea and the Pacific Ocean near shorelines and mouths of rivers; the appearance in the open sea predicts an approaching storm. It was not observed by me in the Black Sea (In ponto a me non observatus)", (v. I, p. 284).

Apparently, Pallas incorrectly took this dolphin for the harbour porpoise when he indicated it for the Black Sea.

Pallas' authority and influence in zoology are so great that some of his absolutely false conclusions were mechanically repeated by very many subsequent researchers. Even in our time, for example in E. Henntschel's report (1937), the Aral Sea is included in the range of the common seal, where as is well known, there are no seals and apparently never have been.

One often comes across references in the literature to a work by A. Sevast'yanov (1816). In addition to that, from the reference to the title of the work, it is obvious that it is a transaltion of one of Pallas' works, where among the descriptions of Crimean domestic and wild mammals, birds, reptiles, amphibians, fishes, insects and molluscs, it is stated: "In the sea are found small seals (Phoca vitulina) and dolphins (Delphinus phocaena) in large numbers", (p. 61).

In a description of the Taurian region by J. Bronewsky (1825), which has more of a geographical rather than a faunal significance, it is stated: "Of the animals, seals (Seehunde) are observed in the vicinity of Sevastopol, and sea pigs (Meerschweine), in large numbers in the Black and Azov Seas," (p. 70). *26

One of the first indications of the existence of the common dolphin in the Black Sea is attributed to the Petersburg academician E. Eichwald (1830). In his report (1831), he gives the common seal (citing Pallas), the monk seal and two species of dolphin (the common dolphin and the harbour porpoise) for the Black Sea.

In the first zoological bulletin by Ivan Dvugubskii (1829-1833), to be published in Russian, there is an indication of the entry into the Black Sea of the monk seal or white-bellied seal from the Mediterranean. The Black Sea ia also included in the range of the sea pig, and regarding the common dolphin, called the "vorvon dolphin (D. delphis)," it is stated that "it is found only in Botany Bay and the Pacific Ocean" (part I, p. 67).

The most accurate composition of the Black Sea dolphin fauna was established by M. Rathke, who in his work devoted to the fauna of the Crimea, published in Petersburg (M. Rathke, 1837), was the first to point out that "the dolphins are very common in the Black Sea. They are caught in large numbers along the Crimean coasts, and particularly near the Bosporus. Particularly numerous are the Delphinus phocaena, and for that reason much larger in dimensions than Delphinus tursio. Delhpinus delphis is less common but I still succeeded in finding two of its skulls near Kerch" (p. 297). The reference to the rarity of the common dolphin most common to the Black Sea should be attributed no doubt to Pallas' influence who disclaimed the presence of this dolphin in the Black Sea.

It is difficult to assume that the common dolphin began to inhabit the Black Sea only from the thirties of the last century and that during Pallas' time this dolphin wasn't there at all.

Despite the appearance of Rathke's work, as usual only two species of dolphin: "Delphinus phocaena (sea pig or chushka[1])" and "Delphini delphidis (vorvon[1])" are cited for the Black Sea in a subsequent article by M. Kaleniczenko (1839, p. 212).

The composition of the Black Sea mammalian fauna was elucidated in a most complete and detailed manner by A. Nordmann (1840), a participant in the so-called Demidov expedition. Describing the mammals according to biological order, Nordmann names two species of pinnipeds for the Black Sea: "1. Phoca monachus Gm." - the monk seal, about which it is stated that it keeps to caves of rocky shorelines of southern and south eastern Crimea and on islands near the delta of the Danube River (p. 25), and 2) Phoca vitulina - The common seal, reference to which is called into question with a question mark.

Of the Cetecea, two species are named: 1) Delphinus phocaena L., about which it is stated that "this is the most common species of dolphin inhabiting the Black Sea. They make their appearance in large schools and enter into the Sea of Azov as well" (pp. 64-65); 2) Delphinus tursio Bonn. and 3) Delphinus delphis L. It is significant that in describing the latter two species and citing Rathke's work, Nordmann makes a cautious post-script: "Pallas was unaware of the existence of the latter two species in the Black Sea" (p. 65). *27

Pallas' influence was particularly strongly reflected in a report by Yu. Simashko (1851) who, having named the monk seal for the Black Sea, includes the Black and Azov Seas in the range of sea pigs. With regard to the other species of dolphin - Delphinus tursio Fabr. - Yu. Simashko confines himself only to the following: "Rathke found a skull of a

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[1] Trans. note : Russian common names for these species.

dolphin on the Black Sea coast in the Crimea which he attributed to this species" (p. 1120). The range of the common dolphin is described by him in the following manner : "... within the boundaries of Russia, it occurs in large numbers in the Baltic Sea and parts of the Pacific Ocean adjacent to Russia" (p. 1119). The Black Sea, as we can see is not named.

Ones attention is drawn to the fact that concerning the species about which Pallas says nothing at all, Yu. Simashko still considered it possible to quote Rathke's work when, speaking of the common dolphin whose existence in the Black Sea Pallas denied, Simashko considers it possible to ignore in this case the indications of Rathke and Nordmann.

In one of his works devoted basically to the ichthyofauna of the Black Sea, K. Kessler (1861) writes: "Of the mammals in the Black Sea, some species of seal and dolphin occur. The seal, however, is scanty and only rarely approaches the northern shore - alone; on the contrary, the dolphins which carry a non too poetic a name here of sea pigs, sometimes swim right up to Odessa in entire schools. Dolphins occur here in two species: the blunt-snouted (Delphinus phocaena L., Phocaena communis Cuv) and sharp-snouted (Delphinus delphis L.)" (p. 36).

Although all of the authors stress the scantity of the seals in the Black Sea, references to the existence of seals there always keep occuring in the literature of the latter half of the last century and even the beginning of the present century. Thus B. Poznanskii (1880), describing from the words of eyewitnesses how an entire school of "Pharaohs, with large muzzles and whiskered" (pp. 30-31) approached Adler's shore during a storm at sea, correctly concluded that these were seals.

The animals, approaching very close to shore, evidently wanted to take advantage of it for a rest but the people crowded along the shore prevented them from doing so and the seals were forced to return to the sea. *28

In a work on the phenology of the Crimea published in Petersburg, N. and V. Köppen (1883) speak of three species of dolphin occuring there, not naming, it is true, precisely which ones. The authors speak of a seal (Seehunde), "called here foka", (p. 235), not giving a specific name either. N. and V. Köppen note that the seal very rarely exposes itself near the shore and that in 1830's one specimen was killed between Kuchuk-Lambat and Karabakh (p. 235).

In 1891 a report on the vertebrates of the Crimea by A. M. Nikol'skii was published. On the basis of preceding authors, three species of dolphin are named in it: Delphinus delphis Linn., Delphinus tursio Bonnat and Phocaena communis Cuv., besides which, regarding the latter species, Nikol'skii writes that this "common dolphin (? - S. K.) occurs in the Black Sea much more often than other species, from where they enter into the Sea of Azov, according to the evidence of Pallas and Nordmann" (p. 90). In explaining the Black Sea representatives of the pinnipeds, Nikol'skii's report not only did not intorduce any clarity, but on the contrary, aggravated that confusion which existed in the literature before its appearance. We will dwell on it in more detail later during our consideration of the Black Sea seal. Presently we will concentrate our attention on the Cetacea inhabiting the Black and Azov Seas.

P. van-Beneden (1892) cites the three species of Black Sea dolphin named by Nikol'skii with a reference to Rathke's work.

Rathke's data on the species composition of the Black Sea dolphin were verified against factual material and were fully corroborated by one of the directors of the Sevastopol Biological Station, a prominent researcher of the Azov-Black Sea basin fauna, A. Ostroumov (1892), who presents the following species in a more contemporary nomencalture: "Phocaena communis Lesson, a living witness of the last glacial period, known to fishermen under the name pekhtun... Tursiops tursio Fabricius, achieving considerable dimensions, reputed by fishermen under the name sea pig... Delphinus delphis Linné - the white sea pig, or white-sided dolphin. "It is possible, writes Ostroumov, "that yet a fourth species of dolphin may be found in the Black Sea - Tursiops parvimanus Lütken, but I have not as yet been able to observe it" (p.220).

The very same species are named in an anonymous travel note "Dolphins of the Black Sea" (1892).

In 1880, a whale entered the Black Sea: a small rorqual which was washed up on the shore near Batumi. Almost the entire skeleton of that whale is preserved in the Kavkaz musuem. G. I. Radde (1899) writes in the *29 catalogue of this museum: "No. 158. Balaenoptera rostrata Fabr. This whale was washed up onto shore near Batumi in May of 1880." It continues, "... missing many vertebrae and several ribs, and a portion of the mandible was sawn off... I measured: length of cranium from for ocpt. to the end of the nose - 2 mtr., the greatest breadth between the orbits - 1.2 mtr.

The discovery of this whale is of great interest. I know of no cases of ancient writers having knowledge regarding a whale passing through the Dardanelles and the Bosporus to gain entry into the Black Sea. In more recent times, this is undoubtedly an isolated incident" (p. 83).

This incident entered into many subsequent reports. The most detailed description was given by A. M. Shugurov (1912, p. 50).

References to two incidences of entry of a small rorqual into the Black Sea occur in contemporary literature, but in the second, no concrete data are presented, while in all of the preceding reports it is emphasized that the occurrence in 1880 was the only one. This was caused evidently, by the fact that Radde's work was incorrectly entitled "The Capture of a Whale in the Black Sea" by V. R. Nikitina (1934, p. 280). and is marked as 1834, whereas it was published in 1899. Evidently this mislead E. N. Mal'm (1938), who mentions two incidents of a whale entering the Black Sea. Meanwhile, Radde's report (1899) concerns that well-known incident in 1880, as was shown above. Following Mal'm, N. A. Bobrinskii (1944, p. 187) repeats the same mistake, and A. A. Kirpichnikov (1949) quotes Bobrinskii's report, and so on. In short, the conviction that there were two occurrences of a whale entering the Black Sea originated only in recent literature. Concrete data, on the other hand concern only the one incident of 1880.

Correlating the above, I am inclined to regard the second incident of an entry of a small rorqual into the Black Sea as a spawn of literary confusion and not as actual fact.

K. A. Satunin in his summary (1903, pp. 9-10) reports that for the Black Sea "of the cetaceans (Cetacea) one should mention a whale (Balaenoptera rostrata Fabr.) washed up on the shore in Batumi in May of 1880. This is the sole occurrence of an entry of a whale into the Black Sea." In general then, he quotes the following species for the cetaceans of the Black Sea: "Tursiops tursio Fabricius - nezarnak dolphin[1]; Delphinus delphis Linn. - common dolphin; Phocaena communis Cuv. - the common sea pig; B. rostrata Müller - whale. Was washed up in Batumi once."

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[1] Trans. note: Again, this is one of the Russian common names used to designate the bottlenose.

V. K. Sovinskii (1902) quotes the same three species of dolphin only in a somewhat different transcription. Hypothetically, with a question mark, he cites also the fourth species reported for the Black Sea by *30
A. Ostroumov (1892).

A. A. Silânt'ev (1903) studying in detail the commercial dolphin whaling industries on the Black Sea, also presents comprehensive and complete information regarding the Black Sea dolphin fauna into which he includes the following species: *Delphinus delphis* L., *Tursiops tursio* Fabr., *Phocaena communis* Cuv. and gives their discoverers. Silânt'ev is the first to entirely correctly note the most common and numerous in the Black Sea is the first and not the third species as was incorrectly noted by researchers prior to Silânt'ev.

In a subsequent report by N. Ya. Dinnik (1910) information regarding the entry of a small rorqual into the Black Sea, similar to that which Radde gave in connection with that incident, is repeated. Following Dinnik Satunin (1914) and others consider that the species composition of the Black Sea dolphin fauna is limited to those three species which were named by Salint'ev and other researchers. The existence in the Black Sea of a fourth species - *Tursiops parvimanus* Lütken - hypothetically proposed by Ostroumov (1892), was thus not confirmed.

Academician S. A. Zernov (1913), the founder of the Russian school of hydrobiology, presents some very interesting and original biological information on all three species of the Black Sea dolphin.

Thus, it can be said that at the beginning of the present century the cetacean fauna inhabiting the Azov-Black Sea Basin were already fully ascertained. If in the future, including the present, there exist any differences of opinion in connection with taxonomic aspects of the individual representatives of these fauna, then no one has any doubts concerning the number of species that comprise them.

It is of course impossible to include the small rorqual into the cetacean fauna of the basin under consideration on the bases of a singular and clearly, an accidental entry into the Black Sea.

Turning to the pinnipeds, we will try to ascertain how many species of seal and precisely which ones, inhabit the Black Sea.

As has been already noted, Nikol'skii's report only heightened the confusion existing in the literature regarding that problem.

Nikol'skii (1891), speaking of the pinniped fauna, named the following:

"25. Pelagius monachus (Herm.)

1840. Phoca monachus Gm. Nordmann, Fauna pont., s. 25

The only indication regarding this species of seal for the Crimea is attributed to Nordmann. According to him, Phoca monachus keeps to the *31 cavernous cliffs of the southern and south-west coasts of the Crimea. In 1834, a solitary seal of large proportions showed up on the cape where the land belonging to the Nikitskii Botanical Gardens ends.

"26. Phoca vitulina Linn.

1. 1785. Phoca vitulina Linn. Fiz. opis. Tavr. obl., p. 169.
2. 1789. " " Hablizl. Beschr. der Taur. stat. p. 295.
3. 1816. " " Sevast'yanov. Tekhn. zhurn., v. I, pt. III, p. 61.
4. 1825. Seehunde Bronewsky. Blicke auf die Südl. Küste Taur. p. 70.

5. 1840. Phoca vitulina? Nordmann. Fauna pont., p. 25.

6. 1883. Seehunde Köppen. Rus. Revue, p. 235.

Although reports of this seal are numerous, evidently it occurs on the Crimean coasts no more often than the preceding one. In earlier times, it is said to have frequented the shores of the peninsula more often. Thus, according to Hablizl, this seal is found in the Black and Azov Seas, rarely occurs on the shore, with the exception of Sevastopol Bay where it is observed relatively often. Nevertheless, it hardly ever enters this bay at the present time. Nordmann did not see this species at all near the shores of the Crimea, which, according to the above-mentioned traveller, is rare in the Black Sea. Bronewsky's and Mr. Köppen's references pertain, in all probability to Ph. vitulina mainly. According to Bronewsky, the seal is caught in the sea opposite Sevastopol. Köppen says that this animal very rarely appears on the shore. In the 1830's one seal was killed between Kuchuk-Lambat and Karabakh" (pp. 61-62).

While Nordmann's indication (1840) concerning its distribution near the shores of the Crimea is that it is singular for the first species presented by Nikol'skii, i.e. the monk seal or white-bellied seal, then for the Black Sea in general, it is far from isolated, since besides Nordmann, Pallas (1811), E. Eichwald (1831), Dvugubskii (1829-1833), Simashko (1851) and others, pointed to the presence of this seal there.

Analyzing Nikol'skii's data concerning the common seal, it should first of all be noted that the number of his references must be shortened by one half. First of all, references 1 and 2 refer to the very same work of Hablizl's, since the second work noted above is the German translation of the Russian original. Secondly, references 4 and 6 are completely irrelevant, since neither Bronewsky (1825) nor the Köppens (1883), when speaking of this seal, cite anywhere its specific name as was already shown during thr review of these works. As a result, references of these *32 auhtors could equally be attributed to the common seal as well as the white-bellied seal. The third reference does not refer to Sevast'yanov (1816) but to Pallas, for I repeat; Sevast'yanov's report is a translation of Pallas' work, who, it is well-known, included in the range of the common seal not only the Black Sea but the Aral Sea as well. To sum up, we see that out of six of Nikol'skii's references, we can consider only three as valid; to Hablizl (1785), Pallas (instead of Sevast'yanov, 1816) and Nordmann (1840), the latter questioning the occurrence of the common seal in the Black Sea with a question mark. Not limiting the discussion to the Crimean coast alone, it can be stated that there were more references in the literature to the distribution of the white-bellied seal or monk seal in the Black Sea toward the time of appearance of Nikol'skii's work than there were to the occurrence of the common seal.

Nevertheless, one must consider as the main and the most serious shortcoming of Nikol'skii's work the fact that he entirely arbitrarily attributed the wild animal killed in the Crimea in the 1830's according to the Köppens, to the common seal. It is clear to any zoologist what an enormous difference there is between indicating the distribution of a specific species in a specific region and information of a bag of a specimen in that region. Meanwhile, all of the subsequent researchers, including the contemporary ones, quoting Nikol'skii, speak about the bag of one specimen of the common seal in the Crimea. Thus, because of Nikol'skii's inaccuracy, a false fact has been implanted in the literature.

In subsequent fundamental works, references to only one species of pinniped, namely the white-bellied seal, occur. Such data are presented for example, by V. K. Sovinskii (1902, p. 182) and K. A. Satunin (1903, p.56).

The most significant information regarding the Black Sea seals were reported by Zernov, who in one of his first accounts about an expedition near the western shores of the Black Sea, indicated that "information was collected on the distribution of the seals near the coast of Bulgaria where the seals are protected by law" (1911, p. 188). In a subsequent account of an expedition near the Anatolian coast, Zernov (1913) notes that "along the Anatolian coast, the seal <u>Monachus</u> <u>albiventer</u> Gray, finally almost exterminated along the Russian shores, occurs not so uncommonly; we succeeded in capturing a live specimen which went into the Musuem of the Academy." Citing Nikol'skii (1891), Zernov continues: "We can state positively that the seals near the Crimean shores, if they do occur, then only unusually rarely, and only near the Tarkhankut-Bokkal coast. Captured by us near Heraclea on the Anatolian coast, the seal *33
belongs to the first species <u>Monachum</u> (<u>Pelagius</u>) <u>albiventer</u> Gray (typical species for the Mediterranean Sea). When it was delivered to us, it was covered with relatively long, dark-chestnut brown hair with a white spot in the shape of butterfly on the abdomen; after he lived with us more than two weeks, besides which he did not want to eat anything and shed its hair heavily. Finally the entire front half of its body became covered with short silver fur, completely different from its summer coat. Further, and the fastest possible observations are necessary, before all of the seals are not yet destroyed, in order to decide if there are actually two seals

in the Black Sea and what kind, and whether or not the difference in seasonal color plays a role here. It was also pointed out to us that two species live near the Anatolian Coast, but it could not be explained to us, more correctly, because we were lacking an interpreter at the time, we were unable to understand what the difference was between them. Being acquainted with some hunters and knowing the habitat of the seal, this can be done with relatively little expense. We saw live seals in the sea three-four times" (pp. 20-21).

Unfortunately, this appeal by Zernov remained "a voice crying in the wilderness" for no research into the Black Sea seal was ever conducted. There is no factual material available for resolving this most interesting issue. One can construct various logical hypotheses based on zoogeographical data and data from literature on the subject, but even if they were convincing, they would still not be able to resolve the issue conclusively.

Zernov (1913a) again assigned to the seals a significant position.

"Hablizl's times (Nikol'skii, "Vertebrates of the Crimea", 1891), when Phoca vitulina was observed in Sevastopol Bay relatively often, have of course passed irrevocably.

During my own journeys on the Black Sea, I collected everywhere information on the seals which are called 'sea bears' in every language around the Black Sea.

There is no doubt that at the present time the seal occurs extremely rarely within the borders of Russia. Over the last 10-15 years one or two specimens have appeared along the Tarkhankut-Bokkal coast in the locality where the 'Seals' Post' of the frontier guard is situated, and where there were undoubtedly many of them previously. Still living today in Sevastopol is a Mr. Kravets who hunted seals near the so-called 'Bears' Caves' near Sevastopol beyond the Kherson lighthouse. At the present time, only several protected specimens still live near the Bulgarian shores near Cape Kaliarka, and only near the shores of Anatolia are the seals still considerable in number. We saw them time and again there in the sea and we obtained one specimen there for the Zoological Museum of the Academy of Sciences. This specimen lived with us for more than two weeks. It was shedding its hair at the time and its entire front *34 quarters had turned from a chestnut brown-black color to siver-grey. Perhaps, although of course not suggesting that this the case, such an extreme change in color is where the indications that there were two species of seal occurring in the Black Sea - Monachus albiventer and Phoca vitulina - originated from" (pp. 253-254).

As we see, Zernov again reaffirms a notion which he expresses somewhat earlier.

This hypothesis of Zernov's is completely well-founded, the more so since the amount of information on the biology of the white-bellied seal is insignificantly small, and there is none at all on shedding in that seal. Zernov's observation on shedding in the specimen captured in September are interesting in themselves.

For all that, Zernov, having acquired a specimen of the white-bellied seal, and repeatedly having seen this seal in the sea, expresses in a cautious way only an hypothesis as to how the notion of two species of Black Sea seal could have originated but does not tackle at all the resolution of the issue as to how many species there are in fact inhabiting the Black Sea.

We will make an attempt, even if not to resolve the issue, then to at least substantiate our point of view in that regard, beginning with zoogeographical data.

In the literature the white-bellied seal is characterized as a typical Mediterranean species. Its area of distribution is mainly the Mediterranean Sea. Thus, J. Allen (1880) includes into the range of this species the Mediterranean, Adriatic and Black Seas, as well as the Madeira coast and the Canary Islands in the Atlantic Ocean. N. A. Smirnov (1908), a prominent expert on pinnipeds, gives the exact same description of the range of this seal. E. Trouessart (1885) notes the presence of this seal near the Mediterranean coast of France. Ognev, speaking in general terms on the range of this seal, notes that it is found in the Aegean Sea as well. Ognev also writes: "This rare seal, scarce everywhere, occurs in the Adriatic Sea more often than in any of the other seas" (1935, p. 445). Ognev names Trieste as the northernmost point for this seal, and quoting sources from literature, establishes its entry into the Black Sea from the Mediterranean. Regarding this seal, Bobrinskii (1944) writes: "Distributed from the Canary Islands through the Mediterranea Sea to the Anatolian coast of the Black Sea. Scarce everywhere. Life habits not investigated."

The sources presented are entirely sufficient for ascertaining the range of distribution of the white-bellied seal. This range, having as its south-western boundary the Madeira coast and the Canary Islands in the Atlantic Ocean, expands to the north east and eastward, taking in all of the Mediterranean Sea, including the Adriatic and Aegean Seas and the Sea of Marmara. The Black Sea is its north eastern boundary. *35

A question automatically arises: if the Black Sea, on the basis of indisputable data, is included in the range of this species, then can one assume that during Hablizl's time this seal came as far as the southern coast of the Crimea? It seems to me that a positive answer can be given to that question. If in the Adriatic Sea the white-bellied seal goes north as far as Trieste, then why could it not go as far as the southern coast of the Crimea in the Black Sea which is situated not farther north, but on the contrary, farther south than Trieste? There is nothing surprising in such an assumption.

Let us now turn to the consideration of the distribution of the common seal or nerpa (Phoca vitulina) also indicated for the Black Sea at one time. It is necessary to acknowledge that the Russian nomenclature for this species is not entirely conclusive. Thus, for example, the expert on pinnipeds, Smirnov (1908), presenting this species, writes: "nerpa (incorrect)" (p. 67). Another expert on pinnipeds, K. K. Chapskii (1941), speaking on the common seal, considers the name given to this species "bookish": considering on the other hand the rarity of this seal in our north, Chapskii comes to the conclusion that to call it a "common seal" is therefore impossible (p. 97). In one of his last works, Smirnov (1935), quoting only the Latin name for this species, notes in parentheses: "The Russian name is confused" (p. 500). And actually, for example in the Far East and in the North, all of the seals of the the genus Phoca are called nerpa. The very same genus in the Caspian Sea is more commonly called tyulen' rather than nerpa and in Lake Baikal the converse is true - more commonly nerpa than tyulen'. Bobrinskii (1944, p. 175) calls the species under consideration the common or spotted seal. Regarding the Caspian one, he writes that it would be more correct to call it nerpa (p. 178). Ognev (1935, p. 512) calls the species under discussion the "common seal."[1]

This list of disagreements in the Russian nomenclature could have been lengthened had it had any significance. It appears to me that inasmuch as the discussion in this case will involve the western subspecies of the species under consideration, to which the name "common seal" will more commonly be applied, then one can keep just to that name.

L. S. Berg (1934) writes the following on the distribution of this seal: "the seal, Phoca vitulina, has an amphiboreal distribution: the typical form occurs from the shores of the Pyrenean[2] Peninsula to the Barents Sea where it is rare and the Baltic Sea; the subspecies largha Pall. is indigenous to the Sea of Japan, Sea of Okhotsk, the Bering Sea and areas of the Bering Strait" (p. 72). Speaking on the typicalness of amphiboreal (discontinuous) distribution of mammals, V. G. Heptner (1936) presents the distribution of this particular seal as an example, illustrating the fact with a geographical chart (p. 407). *36

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[1] Trans. note: As with many Russian common names, this disagreement on the proper usage of common names is not unusual in Russian literature. Another good example of such disagreements (to which a certain author devoted an entire paper) is the issue of whether the name beluhka or beluga is the correct one (as opposed to a "bookish one") to be used for Delphinapterus leucas, a breif account of which is given in S. E. Kleinenberg's book "Belukha". As regards the nerpa vs. tyulen' issue, the situation is no less confusing. It seems that both designations can be used to refer to members of the true seals - Family Phocidae. With respect to the Baikal and Caspian seals - Phoca sibrica and Phoca caspica - they obviously belong to the same genus and are closely related to the Arctic ringed seals - Phoca hispida. In any case both names seem to be used interchangeably, and as the author indicates, it is irrelevant to the issue at hand.

[2] Trans. note: Presumably what the author means is the Iberian Peninsula consisting of Spain and Portugal separated from the rest of Europe by the Pyrenees Mts.

Leaving the distribution of the eastern subspecies, the so-called larga (Phoca vitulina largha Pall.), we will turn to ascertaining the range of a typical form of the common seal relegated today to the western subspecies (Phoca vitulina vitulina).

Smirnov (1908), characterizes the distribution of this seal as the "northern Atlantic" (p. 69). Actually, this seal is widely distributed both throughout the coastal waters of the Northern portion of the Atlantic and along the coasts of Western Europe and North America. However, the American seal is relegated to a separate race (Phoca vitulina conkolor Dekay).

We will examine the distribution of this seal along the European coast in more detail. Inhabiting the north Atlantic waters, it is also very common in the North Sea, in the south-western waters of the Baltic Sea (excluding the Gulfs of Riga, Finland and Bothnia) and is rare in the Barents Sea. F. D. Pleske (1887) indicated that seal for the White Sea as well. But Smirnov (1908) correctly doubts this, since in the large collection of seal skulls collected by Pleske in the White Sea, there was not a single skull which belonged to this species. In recent works, the White Sea is not included in the range of the common seal. Judging by the indications of Smirnov (1908, 1935) and Chapskii (1941), this seal is very rare in the Barents Sea: at the same time, according to Chapskii, it ranges as far as the Western Murman Coast, although there is irrefutable evidence of the fact that this seal ranges as far as the western coast of Novaya Zemlya inasmuch as Smirnov himself (1908) refers to two skulls of this seal which he recovered from there. It has not been detected any farther east than Novaya Zemlya. As a result, the western coast of

Novaya Zemlya can be considered as the north-eastern boundary of the distribution of the common seal. Its inhabitation near the shores of Spitsbergen Ognev (1908) considers as not entirely substantiated. Following south along the coast of Europe, it can be stated that this seal is common to the coast of Norway (beginning from Tromsö), the southern coast of Sweden, the coast of Denmark, as well as to the coasts of Germany (Ognev, 1935). It is also found along the coasts of Holland and Belgium. It is widely distributed along the English coasts, especially in Scotland, but to the south of this country it already occurs less commonly. It is also found near the coasts of Eire, well-known to the coasts of France, but mainly to the Normandy coast and the shores of the Brittany peninsula. Farther south it already becomes rare. It was Allen (1880) who noted the rarity of this seal for the Atlantic coast of Spain, *37 and not indicating it for the coast of Portugal, wrote that only occasional specimens come as far as the Mediterranean Sea. Nevertheless, not one of the authors includes this sea in the range of the common seal. All of them consider that the Atlantic coast of Spain is the southern limit of the distribution of the common seal where it is just as extremely rare it is in the northern limits of its distribution.

Only Trouessart (1885), Smirnov (1908, 1912) and Ognev (1935) quoting the authors cited above, mainly Nikol'skii (1891), speak of occasional entries of this seal into the Black Sea.

Thus zoogeographical data cast doubt on entries of seal into the Black Sea. Even if we admit the notion of occasional entry by isolated individuals, for whom it would be necessary to round the "Pyrenean" Peninsula, pass through the Straits of Gibraltar, traverse the entire

Mediterranean Sea west to east, then the Aegean Sea, the Dardanelles, the Sea of Marmara and enter into the Black Sea through the Bosporus, then in any case, it is inconceivable that such entries could have created a population of seals such as was written about by Hablizl (1785), Pallas (1811), Nordmann (1840) and Zernov (1913b), who had known people that had hunted seal in the Black Sea.

Thus, an analysis of the distribution of both species of seal indicated for the Black Sea leads to the conclusion that habitation of the typical Mediterranean species - the white-bellied or monk seal in the Black Sea is certain. The habitation of the North Atlantic species, i.e. the common seal in that body of water is hardly possible at all.

Let us now turn to an analysis of the factual, and unfortunately, extremely scanty material. We have at our disposal only one concrete case of a bag of a single specimen of the white-bellied seal by Zernov (1913, 1913a) near the Anatolian coast of the Black Sea.

In our day, the white-bellied seal is extremely rare in the Black Sea. Despite the highly intensive research of this body of water, during the last decade not one zoologist has seen this seal in the sea. The last scientific-commercial expedition of <u>VNIRO</u> and <u>Azcherniro</u>, having begun its work in 1948, and working from a large number of vessels, in exactly the same way, failed to obtain any material regarding the seal. In my own twenty years of work on the Black Sea, I only once heard of a case in 1934 where fishermen shot a seal in the sea near Batumi, but which nevertheless sank as they watched. From a conversation with these fishermen, it can only be assumed that it was a white-bellied seal.

Most recently, information has been received to the effect that *38 a small number of white-bellied seals currently occur near the dealta of the Danube, i.e. in the same place as they were reported by Nordmann (1840) as far back as the 1840's. Thus, A. V. Krotov (1952) writes that "from a conversation with fishermen from the city of Vilkovo setting barbless hooks for catching beluga and other 'noble fishes'[1], we were able to establish that during the period 1946 through 1951, there were five cases of seals being caught (the discussion concerns white-bellied seals - S. K.) on such hooks. Such cases are far from unique. Thus, in the Laboratory of Maritime Water Bodies of the Institute of Hydrobiology of the Ukrainian SSR Academy of Sciences, there is a stuffed seal also caught near the Danube delta" (p. 119).

Such is the factual material on the white-bellied seal in the Black Sea. As far as the case regarding the bag of a seal in the thirties of the last century in the Crimea referred to by Nikol'skii (1891) as a bag of a common seal, it is extremely doubtful, for making reference to that fact, the authors do not give a specific name. Thus, this fact can be attributed to the bag of a white-bellied seal with the same (more correctly, even greater) measure of probability. Is it possible that Nikol'skii (1891) based himself on the fact that I. and V. Köppen (1883), calling this seal "Seehunde", a generally accepted collective designation in the German language, made reference in one place to: "called foka here" (p.235), and Nikol'skii took that to mean as the generic name for the common seal? But in addition to that, it is entirely clear from an

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[1] Trans. note: According to Ricker, "noble fishes" are sturgeon and salmonids as contrasted to chastikovye ryby or ordinary fish - species of fish that are not of exceptional size or value; mostly cyprinids and percids.

analysis of the text of the Köppens* work, that the authors used this designation not as the Latin designation for a genus at all, but in the same collective sense corresponding to the German "Seehunde". To this, it is necessary to add that in many Slavic languages the designation "foka" serves as a collective designation for all seals in general.

Material on the common seal is lacking in every one of our zoological museums, and the three skulls of this seal found in the Kavkaz museum, judging by Radde's (1899) catalogue, were obtained from the North and Baltic Seas. Thus, there is no factual material whatsoever on the occurrence of the common seal in the Black Sea, whereas there is irrefutable factual material regarding the occurrence there of the white-bellied seal.

If we turn to the paleontological data on the Quarternary Period, we will see first of all that they are negligibly small. Only in V. I. Gromov's (1948) last report is there a reference to a single remains of a seal, found in a paleolith in the Crimea; "probably Monachus", writes the author (p. 429).

Such infinitesimal data are incapable of shedding light on the issue under discussion.

How then is this issue assessed in contemporary zoological literature? Smirnov, including the Black Sea in the range of habitation of the white-bellied seal without qualification and describing the distribution of the common seal, writes: "on the basis of data from literature, which requires verification, Nikol'skii cites [them - Trans.] for the Black Sea" (1908, p. 69). It is significant that in a subsequent work, Smirnov (1912) does not stop with a statement of Nikol'skii's data (1891) *39 but expresses some doubt regarding these data. Thus, for example, citing the white-bellied and common seals for the Mediterranean and Black Seas, he remarks: "the latter species is highly questionable" (p. 6). In a succeeding work, Smirnov (1935) simply does not include the Mediterranean or the Black Seas in the range of the common seal without even mentioning Nikol'skii's data.

I. I. Puzanov (1929) considers that there is only one species of seal in the Black Sea. "At the present time, the seal Monachus albiventer," he writes, "is completely exterminated near the Crimean shores and occurs only on the opposite Asia Minor shores of the Black Sea and the coast of Bulgaria. But 50-60 years back, seals were still seen on the cliffs near the Kherson lighthouse and on the southern shore" (of the Crimea - S. K.) (p. 27).

S. P. Naumov (1933), discussing the absence of seals in the Black and Azov Seas, and adding a footnote: "The negligible numbers of the monk seal occurring near the shores of Transcaucasia can be disregarded" (p. 9), does not include, of course, the Black Sea in the range of the common seal. Hepner (1936), Puzanov (1938), Chapskii (1941) and others, do not include either the Mediterranean or the Black Sea in the range of this species either.

In a widely reputed report by Ognev (1935), entries of the white-bellied seal into the Black Sea from the Mediterranean were established, as was already noted. Describing the distribution of the common seal, Ognev, incidentally, notes that "according to Nikol'skii (1891), a single specimen was bagged between Kuchuk-Lambat and Karabakh in the thirties of the last century" (p. 50). Finally, in the last guide to the mammals of the USSR by Bobrinskii et al. (1944), the Mediterranean and the Black Seas are included in the range of only the white-bellied seal.

As a result, contemporary authors either simply refrain from indicating the common seal for the Black Sea, completely ignoring the indications of previous authors, or limit themselves to citing Nikol'skii (1891), whose work implanted in the literature the opinion regarding the existence of two species of seal in the Black Sea. On the other hand, verification *40 of the literature data presented by Nikol'skii (1891), the necessity of which, incidentally, was pointed out by Smirnov (1908) and which I have already mentioned, showed the invalidty of many of the author's references. Also found to be groundless was the information presented by Nikol'skii (1891) regarding the bagging of a common seal in Crimea.

We will attempt to ascertain how such a view regarding the existence of two species of seal in the Black Sea could have arisen in the literature.

If we disregard the data presented in Georgi's (1802) and Nikol'skii's (1891) and others' works, representing a compilation of previous studies including that of Nordmann (1890), the first, it is opportune to mention, who doubted the existence of the common seal in the Black Sea, then there are only two completely substantiated indications left in the literature in this regard belonging to Hablizl (1785) and Pallas (1811). Nevertheless, Pallas was able to make this observation only on the basis Hablizl's published work.

Thus we have arrived at the primary source; and here, it appears to me, one should keep in mind one essential consideration. The point is that the white-bellied seal as a species was described only six years prior to the publication of Hablizl's work, i.e. in 1779. On the other hand, the common seal (Phoca vitulina L.) was well known according to Linnaeus' description as far back as 1758. So it is entirely possible that Hablizl (1785), not yet familiar with the white-bellied seal (whose existence in the Black Sea is not subject to doubt), and having discovered it there, and knowing of the distribution of the common seal along the coastlines of Western Europe, named the white-bellied seal Phoca vitulina. If Hablizl had indicated not one, but two species of seal for the Black Sea, then my hypothesis could not have arisen, but since Hablizl cited only one species, then such an hypothesis it seems to me, is entirely plausible.

In this case, it is entirely possible that the name given to the white-bellied seal by Hablizl (1785) and supported besides by the authority of Pallas (1881), who also noted Phoca vitulina for the Black Sea, was simply not connected as a synonym for the white-bellied seal in time. From here the further implantation in the literature of the view regarding the existence of two species of seal in the Black Sea becomes understandible.

Of course, this reasoning of mine is only a guess. Nevertheless, zoogeographical data, factual material, and finally the literature point to the fact that during Hablizl's time, as is the case today, apparently only one species of seal inhabited the Black Sea, and that is the white-bellied seal. The accuracy or inaccuracy of this conclusion, which I have already expressed on one occasion (1951), can be proven in the future only *41 by paleontology.

Data in the literature, especially Zernov's (1913b), confirm that those times when the seal was fairly common to the Crimean coast, and where it was hunted for game by the local population, relatively speaking are not too long ago. Why then did the seal become so scarce in our time? The answer to that question seems to me quite clear.

All Pinnipedia in contrast to the Cetacea, cannot go without a firm substratum, which for them is either ice or land, i. e. islands, shoals, shorelines. Mating, whelping, rearing the young, which during the initial period do not enter into the water at all, and shedding in the animals, are possible only on a firm substratum. These circumstances force the pinnipeds to form so-called rookeries on ice or land for considerably long periods of time annually. I am no longer speaking, of course, of the fact that these animals use the firm substrata for resting as well, which they couldn't do without.

Since certain species are attached to ice floes and others to land, then Smirnov (1912), quite correctly divides the pinnipeds into "pagophiles" to which belong those species forming rookeries on ice floes, and "geophiles" to which the species forming rookeries on land belong. By the way, it is not without interest to mention that such a southern seal, one would think, as the Caspian, spending a significant portion of its life near the southern coast of that sea, would nevertheless be a typical pagophile, forming thick rookeries on the ice floes of the Northern Caspian. This factor serves as one of the irrefutable arguments for the northern origin of this seal. It is true that there are disagreements on this score in the literature. Thus, V. V. Bogachev (1927), on the basis of insignificant fossil material, speaks of the possible ancient endemism of the Caspian Seal. Basing himself on the arguments of Bogachev, Berg (1928) writes: "It is possible that the Caspian seal is an ancient Caspian endemic, a descendant of those seals that lived here during the Middle Miocene epoch, and perhaps evem later..." (p. 109), - and therefore excludes it from a survey of the northern forms of the Caspian Sea. It is difficult to share Bogachev's (1927) and Berg's (1928) point of view on that issue, and it is easier to side with Smirnov's (1912) point of view. There is no doubt that all pinnipeds were originally geophiles and that pagophilism in certain species is already secondary. The conditions in the Caspian, on the other hand, were such that they could not have developed pagophilism on their own. As a result, one must consider that the seal found its way into the Caspian with tendencies towards pagophilism already developed; and once this is so, then it means that Smirnov (1912) is correct in considering that the present-day seal found its way into the Caspian no later than the ice age. *42

The white-bellied seal is of course a geophile, since if it was a pagophile, it could not have existed in that region which it now occupies because of the absence here of an ice cover. As a result, this seal cannot live without using land which is why it chooses shoals, islands and coastlines. In this regard, it is well-known that there are no islands or shoals in the Black Sea, with the exceptions of the deltoid sections of some rivers. Of interest in connection with this is the indication by Nordmann (1840), who noted the white-bellied seal on the islands near the delta of the Danube River. As a result, the seal was forced to make use of only the caastline of the Black Sea. It is entirely natural therefore that with the colonization of the Black Sea coastlines, the seal was simply displaced by man. Indeed, can we imagine seals appearing anywhere along the southern shore of the Crimea now and not being noticed by people? Surely not.[1] But in Hablizl's time (1785) and even in Nordmann's (1840) time, seals could have been using the Crimean coastline.

The biology of the white-bellied seal has not been studied at all. Trouessart (1885) mentions that this seal feeds mainly on fish and Ognev writes that "this species displays a lot of cleverness and has excellent taming qualities".

I dwelt on the seal in somewhat more detail because further on, due to the lack of data, we will not have occasion to return to it again. The succeeding sections of this work will be devoted entirely to the Cetacea.

Thus, on the basis of a review of the faunistic studies of the Azov-Black Sea basin, it can be stated that the mammalian fauna of this basin is limited to one species of pinnipeds and three species of small cetaceans - the dolphins.

2. THE CONTEMPORARY STATUS OF THE CETACEA IN TAXONOMY AND A LIST OF MAMMALS OF THE BASIN

The cetacean fauna of the Black and Azov Seas, established during the beginning of the present century and limited to three species of dolphin, are recognized by all of the contemporay authors. Only N. M. Kulagin (1929), referring to Ostroumov's work (1892), speaks of four species. All of the succeeding researchers quite specifically confine the composition of the Black Sea delphine fauna to three species. *43

Nevertheless, while in the literature there is full agreement on this issue, the taxonomic status of these species has been a subject

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[1] Puzanov informed me that in 1950, about 30 km to the east of Odessa, an animal resembling a seal was sighted by an eyewitness.

of discussion up until recently, and as a result, cannot as yet be considered settled.

Recently, one sometimes hears opinions that taxonomy has no practical significance, and as for the industry, it makes no difference whether we are dealing with a species or a subspecies.

It is impossible to agree with such reasonings for taxonomy in zoology provides, first of all, the necessary basis for any zoogeographical structure, which, when applied to commercial animals, already has practical significance. Questions regarding the origin and formation of both the individual species and entire fauna are inconceivable without classification. Therefore, it is impossible not to agree with Academician E. N. Pavlovskii (1925a) who writes the following in confirming the necessity of the development of taxonomy in our time: "At times voices are heard that 'descriptive' work [such as - Trans.] taxonomy takes it [development - Trans.] back to the beginning of the XIX century and farther when the sole aim in zoology was generally the description of animals. This is an unfair judgement. Firstly, no two descriptions are alike; secondly, if one can achieve a necessary goal, then there is nothing dishonourable in doing even what Aristotle did many centuries ago. And what is more, one should use whatever means are actually useful, not being embarassed by the 'external appearance' of a method being applied and its apparent primitiveness" (p. 172).

Taxonomists confused the taxonomic status of the Azov-Black Sea dolphin very badly, therefore I consider it necessary to sort the issue out.

A revision of the taxonomic status of our dolphins was initated by O. Abel (1905). After studying only one skull of a female Black Sea sea pig sent to him by Zernov, Abel relegated this dolphin to an independent species which he called Phocaena relicta. In the same work, he described Palaeophocaena andrussowi from fossil remains of a skull from Miocene deposits of the Taman' Peninsula; on the basis of which, he considered it possible to regard the present-day sea pig of the Azov-Black Sea basin as a relict form of the southern Russian Sea basin which existed during the Miocene Period, and the fossil form, as primordial for all of the contemporary species of the genus Phocaena.

The inhabitation of this genus, having initially developed in the Southern Russian Miocene basin, in Abel's opinion proceeded through the strait that connected this basin with the region now occupied by the Atlantic Ocean during the Middle Miocene period, and that passed along the external fringe of the Carpathians and the Alps.

We will dwell on the reason for the error of an authority on paleontology and taxonomy of dolphins such as Abel when we turn to the history of the formation of the mammalian fauna of the Azov-Black Sea basin. Right now, I only want to mention that the relegation of the Black Sea pig to an independent species was one of the most unnecessary elements that entered into the entire concept established by Abel, and then describing this species, even if it was on the basis of one skull, was of course, very tempting for Abel. *44

In 1935, I. I. Barabash, basing himself on the vast collections of the VNIRO expedition and that of the Georgian Scientific Commercial Fisheries Station, relegated the Black Sea common dolphin or white-sided dolphin to an independent subspecies, having described it under the name Delphinus delphis ponticus.

In a subsequent work I. I. Barabash-Nikiforov (1938) strives to prove the systematic heterogeneity of the Black Sea population of the common dolphin. Within the subspecies which he isolated, he distinguishes the north-eastern, i.e. the Yalta-Novorossiisk, and the south-eastern or Batumi or Anatolian races (nationes, as the author writes on p. 1102).

In 1938 V. I. Tsalkin, basing himself on a large amount of material, convincingly demonstrated the lack of grounds for the relegation of the Azov-Black Sea harbour porpoise to an independent species by Abel (1905) and reduced this species to a "poorly considered subspecies" (V. I. Tsalkin, 1938, p. 274), having proposed calling it Phocaena phocaena relicta Abel.

In 1940, Barabash-Nikiforov again produced a taxonomic revision; only on this occasion, of all of the species of the Black Sea dolphin. Giving yet a broader basis for establishing a Pontic subspecies of the common dolphin, Barabash-Nikiforov relegates the Black Sea bottle-nose dolphin to a subspecies as well, naming it Tursiops truncatus ponticus. Concerning the harbour porpoise, the author, despite all of the cogency of Tsalkin's work (1938), again returns to Abel's position, attaching to this dolphin the importance of an independent species.

Drawing on a large amount of material, Barabash-Nikiforov returned to a view regarding the morpholoigical heterogeneity of the common dolphin which he expressed in 1938.

Barabash-Nikiforov's conclusions were subjected to entirely correct criticism on the part of Tsalkin (1941) who came to the conclusion while reviewing this work, that "the issue regarding the taxonomic status of the Black Sea population of D. delphis should be considered open" (p.

177), and that to relegate the Black Sea population of the bottle-nose dolphin to a subspecies, as well as to attach the importance of a species to the harbour porpoise is without basis.

The establishment within the Black Sea population of the common dolphin of two races was subjected to even sharper criticism. We will dwell later on the arguments of the authors cited above.

Tsalkin's views on the classification of all the cetaceans of the Azov-Black Sea basin were shared by me (Kleinenberg, 1951) even before all of the extent material was analyzed.

Somewhat later, S. L. Delamure (1952, 1955), on the basis of a study of the helminthofauna of the Black Sea dolphins and dolphins of the same species from other bodies of water, reinforced Tsalkin's and my views (1951) regarding the classification of the Black Sea bottle-nose dolphins and harbour porpoises. At the same time, Delamure (1952) sided with Barabash-Nikiforov's view (1940) regarding the common dolphin, considering the Black Sea population of this dolphin to be a subspecies.

The other authors, cited in favor of one or another systematic revision - without touching on their arguments - accepted either Barabash-Nikiforov's (1940) point of view, or that of Tsalkin (1938).

Such is the status in the taxonomy of the Azov-Black Sea dolphins. As we can see, the views of the different researchers are varied that even up until the present time, the taxonomic status of the Azov-Black Sea Cetacea cannot be considered clear even for one form which is clearly evident form Table 2.

We will attempt to examine the arguments of the various researchers. Keeping to a chronological order, we will begin the analysis with the status of the harbour porpoise.

Table 2 *Таблица 2*

1. Взгляды на систематическую категорию черноморских дельфинов различных авторов

(2) Наименование животного	(3) Систематическая категория						
	a. по Абелю (1905)	b. по Барабаш-Никифорову (1935, 1938, 1940)	c. по Цалкину (1938, 1941)	d. по Томилину (1940, 1947, 1951)	e. по Фрейману (1951)	f. по Клейненбергу (1951)	g. по Делямуре (1952)
(4) Морская свинья	a' Вид	a' Вид	b' Подвид	b' Подвид	a' Вид	b' Подвид	b' Подвид
(5) Белобочка	—	b' Подвид	c' Типичная форма	„	b' Подвид	c' Типичная форма	„
(6) Афалина	—	„	c' То же	„	„	c' То же	c' Типичная форма

Key to Table 2:

1. Views on the taxomomic category of the Black Sea dolphins of various authors.

2. Name of animal 3) Taxonomic category a) According to Abel (1905)

b) According to Barabash-Nikiforov (1935, 1938, 1940)

c) According to Tsalkin (1938, 1941)

d) According to Tomilin (1940, 1947, 1951) e) According to Freiman (1951)

f) According to Kleinenberg (1951) g) According to Delamure (1952)

4. Harbour porpoise 5) Common dolphin 6) Bottle-nose dolphin

a') Species b') Subspecies c') Typical form

Abel (1905) discovered a number of craniological differences in the skull of an old Black Sea female harbour porpoise in comparison with the Atlantic dolphins of the same species to which he attached the significance of differential features in the description of the species. Distinguishing the species, they are according to Abel (1905): *46

1) a considerably greater steepness in the contour of the occipital region;

2) smaller diameter of the external nares;

3) larger size of the temporo-parietal fossa;

4) a greater curvature of the supraorbital or superciliary arch;

5) teeth are lacking the "drawn-out portion" or neck between the root and crown characteristic of this dolphin due to which they have a "cutter-like" appearance;

6) the blowhole is shifted farther back;

7) a greater length of the rostrum and a greater breadth of the rostrum at its base;

8) the roots of the teeth of the maxilla are highly curved, locked and thickened.

Despite the fact that Abel himself notes the great variation in the shape of the cranium in the Atlantic dolphins, he nervertheless considers it possible to describe the Black Sea harbour porpoise as a species on the basis of the above features, having studied only one skull.

A. A, Brauner (1923) adds yet another to the features indicated by Abel; namely, the shape of the foramen magnum. He considers that the foramen magnum in the Azov-Black Sea harbour porpoise has the shape of a pentagon and that its height is greater than its breadth, whereas in the same dolphins from the Atlantic Ocean it has the shape of an oval with a greater breadth than height.

Let us analyze the noted features.

The first of these features indicated by Abel (1905) - the considerably greater steepness in the contour of the occipital region is nothing other than one of the features of age variability of the skull, a fact which was so convincingly demonstrated by Tsalkin (1938). It is only seen in specimens of old individuals and is caused by a vigorous growth of the occipital crest. In younger individuals, the occipital region has a spherical shape. I can only associate myself completely with Tsalkin's conclusion for our material confirms his conclusions. I will only add that the development of the occipital crest in old age is characteristic to some degree for other Black Sea dolphins although it is manifested less sharply than in the harbour porpoise (see Figs. 4, 5, 6).

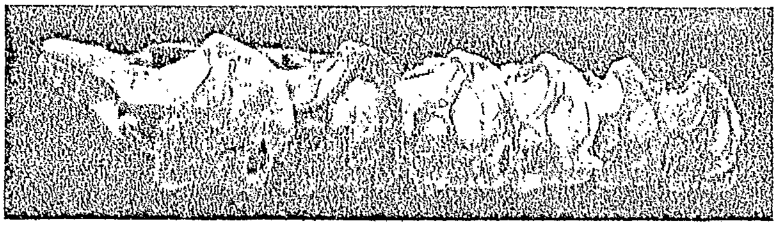

Рис. 4. Возрастная изменчивость в развитии затылочного гребня у морской свиньи (по В. И. Цалкину).

Fig. 4. Age variability in the development of the occipital crest in the harbour porpoise (by V. I. Tsalkin).

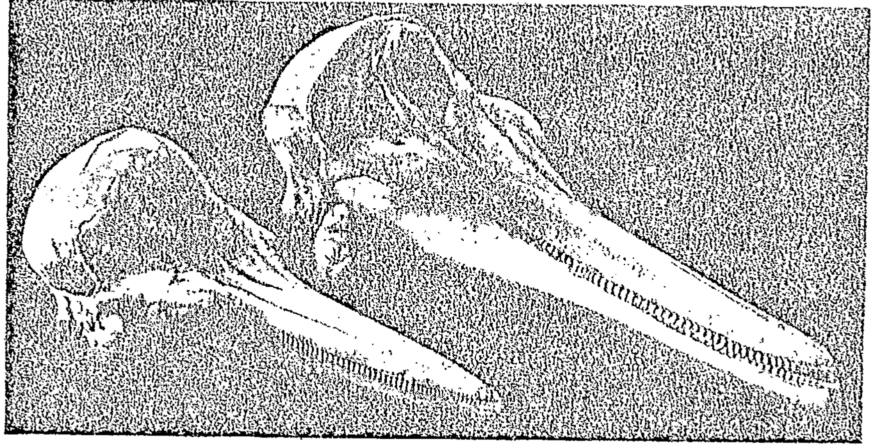

Рис. 5. Возрастная изменчивость в развитии затылочного гребня у белобочки (оригин.).

Fig. 5. Age variability in the development of the occipital crest in the common dolphin (origin).

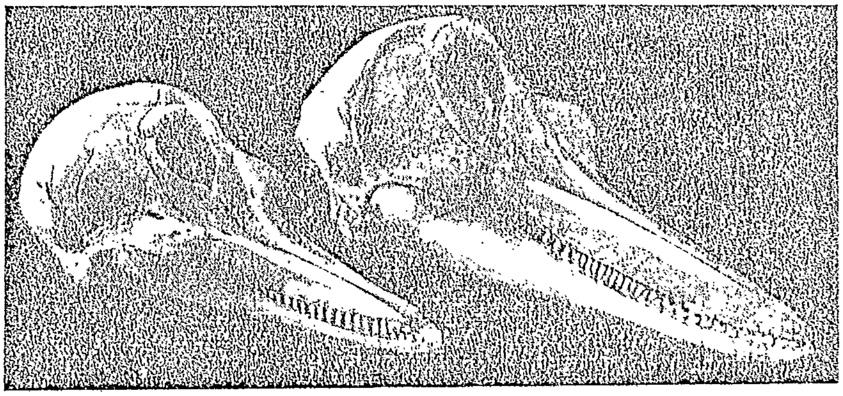

Рис. 6 Возрастная изменчивость в развитии затылочного гребня у афалины (оригин.).

Fig. 6. Age variability in the development of the occipital crest in the bottle-nose dolphin (origin.)

The second, third, fourth and fifth features indicated by Abel (1905) are the result of individual variability of the cranium which shows up quite clearly in a large series, a fact so convincingly demonstrated by Tsalkin on his vast series (383 specimens) of Black Sea harbour porpois skulls. *48 Our lesser amount of material completely supports Tsalkin's data. Thus, for example, the diameter of the blowhole in adult individuals, according to Tsalkin (1938), varies from 24 to 31 mm which is consistent with our data.

According to Tsalkin's data (1938), the variability in the size of the temporo-parietal fossae is just as great. According to our data, the length of the temporo-parietal fossa in adult Black Sea specimens varies from 57 to 68 mm, and the height, from 34 to 42 mm. The same may be said concerning the curvature of the supraorbital arch.

Dimorphism according to the sex of the individual, which quite definitely shows up on the cranium of that dolphin, was also demonstrated by Tsalkin (1938). Our material completely supports these data which are clearly evident from Table 3 presented below.

The incomplete correspondence between the figures presented by Tsalkin and myself is explained primarily by the fact that the average dimensions of the skulls measured by us differ considerably while the Table is given in absolute figures. Nevertheless, the Table indicates the quite distinct sexual differences which are clearly evident from the presented figures. First of all, it should be noted that the cranium of the female is larger than that of the male, the increase in the size of the female being attributed to the growth of the facial section. Consequently, our material supports the conclusions made in that respect by Tsalkin (1938).

The fifth feature indicated by Abel (1905) - the shape of the teeth, i.e. their "cutter-like" nature in the Black Sea dolphins versus the "leaf-like" or lammellar crown in the Atlantic individuals - is also attributed to individual variability by Tsalkin (1938). In fact, the shape of the teeth varies immensely which is clearly evident on the photographs (see Figs. 7, 8). A picture of a cranium of this dolphin, equipped with conically shaped teeth similar to the shape indicated by Tsalkin (see Fig. 8), presented by Bell (1874), supports Tsalkin's data (1938). As a result, such deviations from the typical shape of the teeth occurs not only in the Black Sea, but in the Atlantic harbour porpoises as well.

Also attributed to individual variability is Braumer's (1923) feature of the shape of the foramen magnum which shows extreme variation not only in harbour porpoises but in other species of Black Sea dolphin as well (see Figs, 9, 10, 11).

The variabilty of this feature is also noted by Barabash-Nikiforov who writes the following regarding the other features which I analyzed below: "The remaining diagnostic features relating to the configuration of the cranium of Ph. relicta presented by Abel (larger dimensions of the temporo-parietal fossa, smaller nasal passages, a rostrum that is longer and wider at the base, a larger curvature of the supraorbital region) were not supported by our material (as well as by Tsalkin's materal)" (p. 68). Nevertheless, this did not prevent Barabash-Nikiforov from * 50 siding with Abel's (1905) position on the view regarding the taxonomic status of the Black Sea Harbour porpoise. We will dwell on his conclusions in this respect later. Right now, it is important to emphasize that many researchers, both those holding to Abel's position (1905) and those disputing it, recognize many of the features indicated by him for relegating the Black Sea harbour porpoise to an independent species as unfounded.

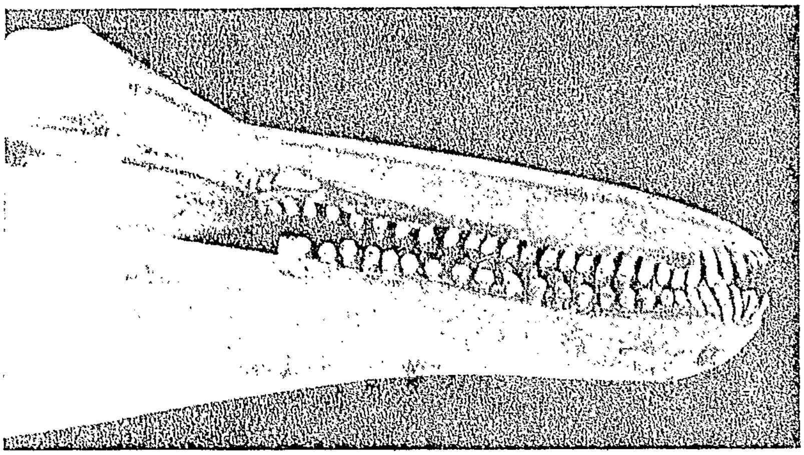

Рис.7. Типичная форма зубов морской свиньи (по В. И. Цалкину).

Fig. 7. Typical shape of the teeth of the harbour porpoise (by V. I. Tsalkin).

Table 3

Таблица 3

(1) **Сопоставление измерений черепов взрослых самцов и самок морских свиней Азово-Черноморского бассейна (в мм)**

(2) Признаки	(3) Наши данные		(4) По В. И. Цалкину	
	5. средние для самцов (*n*=6)	6. средние для самок (*n*=6)	7. средние для самцов (*n*=32)	8 средние для самок (*n*=32)
a. Длина черепа	246,7	256,6	254,8	262,9
b. Длина межчелюстных костей	148,7	153,7	157,7	163,7
c. Длина лицевого отдела	142,3	148,6	141,0	149,2
d. Длина мозгового отдела	104,4	108,0	113,8	113,7
e. Длина рострума	109,3	112,0	109,2	111,9
f. Длина верхнего альвеолярного края	94,2	100,0	94,7	100,3
g. Наибольшая ширина черепа	143,0	148,3	144,8	151,5
h. Межглазничная ширина	117,8	122,1	119,2	124,7
i. Наибольшая ширина мозговой коробки	119,6	120,6	121,7	122,3
j. Высота затылочной области	108,2	108,2	108,6	111,9
k. Наибольшая высота черепа	120,3	123,8	116,1	118,4
l. Ширина рострума у основания	70,2	74,7	69,4	73,1
m. Ширина рострума в средней части	43,9	45,7	45,4	48,3
n. Ширина развилки межчелюстных костей	35,0	37,0	35,0	36,4
o. Поперечный диаметр дыхала	26,7	27,5	26,9	27,8
p. Высота рострума позади последнего зуба	18,7	19,2	17,9	19,8
q. Длина височно-теменной впадины	59,0	62,8	50,1	52,0
r. Высота височно-теменной впадины	36,2	37,8	41,1	43,1
s. Длина основной кости	63,7	64,5	63,9	65,3
t. Длина нижней челюсти	188,0	198,3	193,1	200,8
u. Длина нижнего альвеолярного края	89,8	96,8	91,1	95,8
v. Ширина основания нижней челюсти	48,1	50,2	50,4	51,5
w. Высота нижней челюсти позади последнего зуба	26,1	27,8	27,3	28,1
x. Длина преддыхала	33,0	33,6	31,5	36,8

Key to Table 3: *49

1. A comparison of skull measurements of adult male and female harbour porpoises of the Azov-Black Sea basin (in mm).
2. Features 3) Our data 4) According to V. I. Tsalkin
5. Average for males (n=6) 6) Average for females (n=6)
7. Average for males (n=32) 8) Average for females (n=32)

a) Length of cranium
b) Length of premaxillaries
c) Length of facial section
d) Length of cerebral section
e) Length of rostrum
f) Length of upper alveolar row
g) Greatest breadth of cranium
h) Interorbital breadth
i) Greatest breadth of braincase
j) Height of occipital region
k) Greatest height of cranium
l) Width of rostrum at its base
m) Width of rostrum in midlength
n) Width of premaxillary bifurcation
o) Transverse diameter of blowhole
p) Height of rostrum behind last tooth
q) Length of temporo-parietal fossa
r) Height " " " "
s) Length of basilar process
t) Length of mandible
u) Length of lower alveolar row
v) Width of base of mandible
w) Height of mandible behind last
x) Length of prenarial triangle[1]

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[1] Trans. note: Unfortunately, I was unable to find the term preddykhalo in any dictionary available to me, however the term itself suggested something that was anterior to the external nares. In reading a discussion on the structure of the cranial skeleton of dolphins in some literature, I came across the term "prenarial triangle or shield" and from the description I presumed that this term might be synonymous to the term the author is referring to. On examining a skull of a beluga at the University of Alberta Science Museum, I noted that there is in fact a distinct triangular process with its base at the anterior margin of the blowhole and its apex between the premaxillaries. Unfortunately, I could not verify this for a dolphin since the entire skeleton of a species of Phocaena also contained at the museum was on loan.

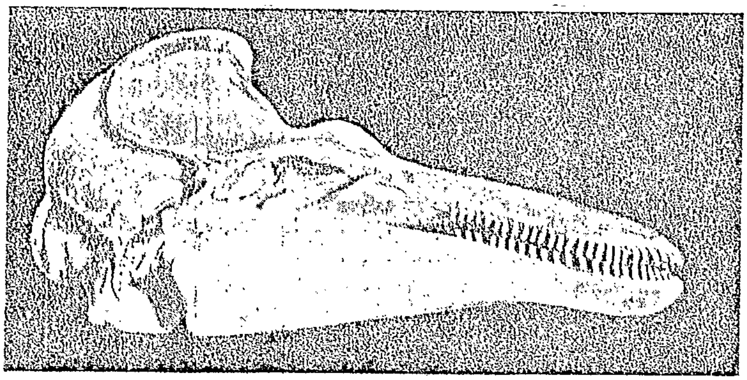

Рис. 8. Индивидуальная изменчивость формы зубов морской свиньи (по В. И. Цалкину).

Fig. 8. Individual Variability of the shape of the teeth in the harbour porpoise (by V. I. Tsalkin)

Let us return to the remaining features indicated by Abel (1905).

The sixth and seventh features, i.e. a more posterior location of the blowhole from the anterior tip of the rostrum, and a greater length of the rostrum with a greater width of the rostrum at its base, were refuted by Tsalkin (1938) by comparing the measurements of eight skulls *51
of Black Sea harbour porpoises with those of four skulls corresponding in dimensions presented by True (1885, 1889) for the Atlantic form. By this comparison (on the basis of seven measurements) Tsalkin (1938) did not find any significant differences. All of the differences do not go beyond the bounds of 1-2 mm, and therefore, as the author correctly concludes "they cannot be regarded as differential features" (p. 720)

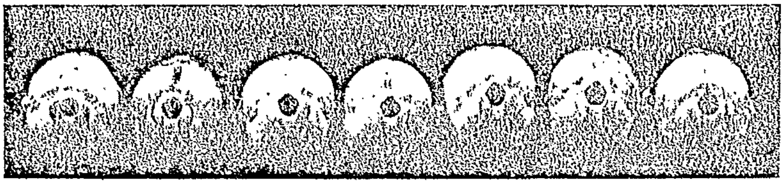

Рис. 9. Индивидуальная изменчивость формы затылочного отверстия у морской свиньи (по В. И. Цалкину).

Fig. 9. Individual variability in the shape of the foramen magnum in the harbour porpoise (by. V.I. Tsalkin).

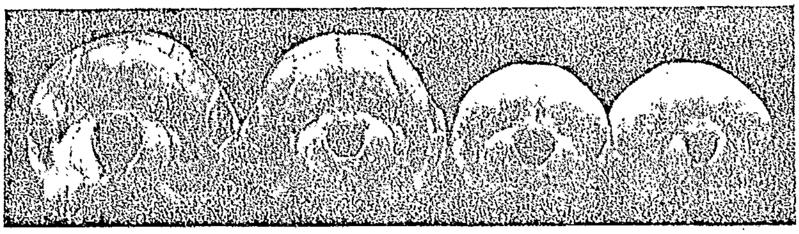

Рис. 10. Индивидуальная изменчивость формы затылочного отверстия у белобочки (оригин.).

Fig. 10. Individual variability in the shape of the foramen magnum in the common dolphin (origin.).

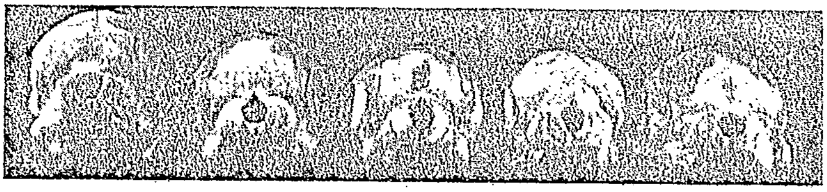

Рис. 11. Индивидуальная изменчивость формы затылочного отверстия у афалины (оригин.).

Fig. 11. Individual variability in the shape of the foramen magnum in bottle-nose dolphin (origin.)

Having in mind such a comparison, I made measurements on three harbour porpoise skulls from other bodies of water contained in the collection of the USSR Academy of Sciences Zoological Museum: No. 11442 from an amimal from the Gulf of Finland; No. 21983, apparently from the Seas of the Far East (the collector was Grebnitskii) and No. 6887 from the Atlantic Ocean. Selecting three skulls corresponding in dimensions from our collection belonging to animals caught in the Black Sea, I compared the results of the measurements.

All of these data are presented in Table 4.

Table 4

Comparison of the skull measurements of harbour porpoises from the Azov-Black Sea basin and other bodies of water (in mm).

(1) Признаки	2. Наши данные		3. По В. И. Цалкину	
	4 средние для 3 черепов азово-черноморских дельфинов	5 средние для 3 черепов дельфинов из других водоемов	6 средние для 8 черепов азово-черноморских дельфинов	7 средние для 4 черепов дельфинов из других водоемов (по Тру)
8) Общая длина черепа	262	262	264	264
9) Длина лицевого отдела	144	145	147	146
10) Длина мозгового отдела	117	117	117	118
11) Длина рострума	113	111	113	112
12) Ширина рострума у основания . . .	76	76	74	76
13) Ширина рострума в средней части .	47	46	48	40
14) Длина нижней челюсти	202	202	202	203

Key to Table 4:

1) Features 2) Our data 3) According to Tsalkin

4) Mean measurements for three skulls of the Azov-Black Sea dolphin

5) " " " " " " dolphins from other water bodies

6) " " " eight " " the Azov- Black Sea dolphin

7) " "" " four " " dolphins from other water bodies (According to True).

8) Over-all length of cranium 9) Length of facial section

10) Length of cerebral section 11) Length of rostrum

12) Width of rostrum at its base

13) Length of rostrum in midlength 14) Length of mandible

As we can see, the Table gives almost identical figures for the measurements presented by Tsalkin (1938), True (1885, 1889) and myself. The only substantial noticeable difference is in the sixth measurement from True's data which may be explained by the fact that the author took this measurement on a point of the rostrum different from the one where it was taken by Tsalkin and myself, since the configuration of the rostrum is such that in determining the midlength by approximation, the result can be a different measurement altogether.

As to the features that served as differential features for Abel (1905) in the establishment of the Black Sea species, i.e. the length of the facial section (the distance between the end of the rostrum and the blowhole), the length of the rostrum and its width at the base, there were no substantial differences observed either between True's and Tsalkin's data or between ours. The differences here do not go beyond the

the bounds of 1-2 mm and therefore cannot be considered as having any significance. Thus our material completely confirms Tsalkin's conclusion (1938) which he drew from such a comparison concerning features indicated by Abel (1905). *53

The eigth feature of the ones indicated by the latter author is the greater curvature, more of a locked nature and more thickening of the roots of the maxillary teeth in the Black Sea dolphin as compared with the Atlantic ones. With respect to Tsalkin's work (1938), he had at his disposal the skulls of only Black Sea individuals, and not having the opportunity to compare them with ones from the Atlantic, he was only able to ascertain the presence of this feature in specimens of old individuals. It was this feature in particular, including an intense reduction in the cutaneous armour [a feature not indicated by Abel (1905), on which we will dwell later on] which allowed Tsalkin to classify the Black Sea harbour porpoise as a poorly considered subspecies. Nevertheless, an examination of the skulls of this dolphin not from the Black Sea, preserved in the USSR Academy of Sciences Zoological Museum indicates that even this feature was not peculiar to the Black Sea individuals alone, to say nothing of the fact that the number, shape and set of the teeth are subject to considerable individual variation. An examination of even such a small series as I had at my disposal, and corroborated on the basis of a large series of skulls by Tsalkin (1938) is a sufficiently convincing indication of this fact.

Consequently, all of the features indicated by Abel (1905) in describing the Black Sea species as diagnostic, are either provem to be unfounded when a comparison is made on several skulls, or are the results of age, sex or individual variability, i. e. also found to be without basis.

Let us examine the features on the basis of which Barabash- Nikiforov (1940), even after Tsalkin's work (1938), still tends to lean toward Abel's position and retains the importance of a species for the Black Sea form of Phocanea. Barabash-Nikiforov (1940) formulates the following features: 1) somewhat smaller over-all measurements; 2) a considerably smaller degree of manifestation of cutaneous tubercles on the body of the embryo and adult animals; 3) a considerably lesser degree of development of polyconic teeth; 4) intense curving, locking and thickening of the inferior sections of the roots of the teeth; 5) a blowhole which is located somewhat farther back; 6) a more angular scapula and sternum. "The last two features," writes Barabash-Nikiforov, "require confirmation on a large amount of material; the remaining ones can be considered established" (pp. 70-71). Taking this indication into consideration, we will not dwell on the last two features. It will be recalled that the lack of grounds for the fifth feature was demonstrated by the second measurement in Table 4.

Let us turn to the "fully established" features in order.

*54 Tsalkin (1938), having at his disposal the largest amount of material (1394 measurements of the over-all length of the body), gives the following outer limits of the body size of this dolphin: length 86-100 cm with a mean of 139.0 cm; for adult females - 148.5 cm, adult males - 141.5 cm. Barabash-Nikiforov (1940), on the basis of 74 measurements of body length, gives the outer limits of 95 - 148 cm with a mean length 126.1 cm. The maximum limit for females of 180 cm and 168 cm for males was given by Freiman (1951). Our measurements of 50 specimens set the outer limits of the dimensions as 95-157 cm with a mean length of 127.3 cm.

Dimensions of 120 to 150 cm are given in the literature for the Atlantic dolphin of the same species (G. Cuvier (1797); A. Lesson (1828); G. Nilsson (1847); P. Duncean (1184)); P. Fischer (1867) gives the maximum size at 186 cm, G. Gibel (1874) indicates 90-150 cm as the outer limits. W. Flower (1883) determined the size of that dolphin as 150cm. F. Beddard (1900) as 165 cm; I.Millais (1906) considers 120-170 as the outer limits of body size; L. Fruend (1932) and E. Hennstchel - from 150-180 cm, etc.

After correlation all of the above figures presented, it is not difficult in becoming convinced that the differences between the sizes of the Black Sea dolphins and the Atlantic dolphins are in some cases much smaller than in the sizes of the same dolphin being indicated by the various authors, which is explained, of course, by the different amount of material that every author had at his disposal. In fact, if we make a comparison, for example, within the data on the Black Sea where the series of measurements of the various authors differ according to their number, then we will see a substantial difference in both the maximum and mean sizes.

If we compare the figures presented by Tsalkin (1938) with the figures for the Atlantic dolphins, then we will find differences in them definitely indicating a larger body size in the Atlantic dolphin.

That is how the matter stands with the first feature presented by Barabash-Nikiforov (1940) in support of the establishment of a Black Sea species of harbour porpoise.

Let us examine the second feature indicated by this author, and one that was noted by Tsalkin (1938) as well.

In the embryos of the harbour porpoise in contrast to other Black Sea dolphins, small corneous tubercles the size of a pin head appear on certain parts of the body and are considered by some researchers as rudiments[1] of a cutaneous armour which once existed in the distant ancestors of these animals. These tubercles, well-known even to ancient authors, were subsequently described by P. Camper (1820), J. Gray (1865), W. Kükenthal (1890) and others, besides which Gray (1865), incorrectly took the tubercles which he discovered as a distinctive feature on the basis of which he even described a new species, Phocaena tuberculifera from the mouth of the Temza, later to be reduced to a synonym.

P. Camper (1820) discovered these tubercles on the anterior margin of the dorsal fin and on the back of the animal - in front of the dorsal fin. Kükenthal (1890, 1893), on the embryos that he saw, counted 25 tubercles each on the dorsal fins and 30 each on the caudal fin and on the anterior margin of the pectoral flippers. Tsalkin (1938) saw these tubercles in embryos of the Black Sea dolphin and only on the dorsal fin; 12-16 in number and at times, 18-20 on a single specimen. Barabash-Nikiforov found 13-15 of them in the same place. This fact in particular, i.e. the disclosure of tubercles on the dorsal fin in fewer numbers, gave occasion for the last two authors to speak of the reduction of this feature in the Black Sea population. At the same time, on our small amount of material (six embryos in all), these corneous tubercles were

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[1] Trans. note: The Russian term used here is rudiment which can be interpreted in the sense of "vestigial" in that sentence. I am using the term "rudiment" as one of the meanings given in Webster's - "The vestige or remains of a part functional only in an earlier stage of the same individual or in his ancestors".

evident not only on the dorsal fin, but on both lobes of the caudal fin as well, and some suggestions of tubercles were noted on the anterior margin of the pectoral flippers. The degree of manifestation and the number of tubercles are extremely highly variable. Thus, I counted between 7 and 13 of them on the dorsal fin and between 12 and 36 on the caudal fin on a single embryo. Tsalkin (1938, p. 711) also notes the variation in the number and size of these tubercles.

As a result, our material makes possible the conclusion: 1) that these tubercles in the Black Sea form are localized not only on the dorsal fin, where Tsalkin (1938) and Barabash-Nikiforov (1940) noted them, but also on those parts of the body where they were noted in the Atlantic forms as well, and 2) that the degree of manifestation and the number of these tubercles vary highly.

A question automatically arises: is it possible, taking into consideration that which has just been said, to speak of a positively displayed reduction of the corneous tubercles on the body of the Black Sea dolphin in comparison with the Atlantic form on the basis of comparison with data on isolated specimens of the Atlantic form? In my opinion, it is impossible. Therefore, I cannot agree with the conclusion drawn by Tsalkin and Barabash-Nikiforov in that respect.

But let us assume that the conclusion of these two authors is correct, and that in the corneous tubercles is in fact observed. Is it *56
possible to speak of a species distinction of a Black Sea form on the basis of this? In my opinion, it is also impossible, for in this case, we would be making the same error as Grey (1865) did in his time, and

our species, just as the species he described will inevitably be reduced to synonymy. Nevertheless, Barabash-Nikiforov (1940) attributes the significance of a species exactly to this feature. He writes: "one gets a different picture when the quantitive aspect of the differences is considered. Among the diagnostic features of *Ph. relicta* we can discern extremely important ones, even if superficial and insignificant ones. To their number should be added the difference in degree of cutaneous corneous tubercles in *Ph. relicta* and *Ph. phocaena*. This difference, clearly displayed in the early (embryonic and post-embryonic) stages of development in the animals, can sooner be considered a feature of species differentiation(since subspecies in the early stages are indistinguishable)" (p. 71). In this case, it is impossible to agree with this conclusion. These tubercles are faintly discernible in general and are obvious rudiment. As a weakly developed rudimentary organ, they are clearly discernible in some specimens of the same species; in some they are faintly discernible, and in some not at all.

Only the following remains to be added to this. If these tubercles are considered a rudiment of a former cutaneous armour in the ancestors, and if it is accepted that in comparison with the Atlantic ones a reduction of this organ is observed in the Black Sea dolphins, then one must inevitably accept the greater progressiveness of the Black Sea form, a fact that Tsalkin (1938) correctly notes as well. Nevertheless, this situation goes contrary to Abel's conception (1905), who considers the Black Sea form as a relict one, i.e. the most ancient. It is therefore impossible to support Abel's position using the reduction of this feature in the Black Sea forms as Barabash-Nikiforov does.

The third and fourth features, formulated by Barabash-Nikiforov (1940), i.e. the shape of the the teeth and their roots, correspond to the features already examined by Abel (1905). It therefore makes no sense dwelling on them again. I will only mention that concerning the third feature, Barabash-Nikiforov himself writes the following: "As we can see, the picture described on the basis of our material to a significant degree although not entirely, confirms this diagnosis. Nevertheless, according to Tsalkin's data, the structure of the teeth in Ph. relicta in this section are subject to broad individual variability, displaying a series of transitions from teeth almost conical to ones with a clearly demonstrated 'lamellar crown'." Thus, even this feature cannot be considered sufficiently stable.

The same can be said regarding the neck between the root and the crown as well, which, according to Abel, is peculiar to Ph. phocaena and is absent in Ph. relicta" (p.69). As a result, Barabash-Nikiforov himself, recognizing the unreality of this feature, as a diagnostic feature, nonetheless presents it as a differential feature for establishing a Black Sea species. *57

Thus our analysis of the features indicated by Abel and Barabash-Nikiforov, on the basis of which these authors consider the Black Sea harbour porpoise an independent species, leads to a conclusion that they are all unreal. The same can be said about the features on the basis of which Tsalkin regards this dolphin as a subspecies as well. Hence no essential differences in the morphology of the Black Sea and Atlantic forms are observed, and all of the features presented in the literature as differential features, are a result of a widely distributed age, sex and individual variability among all of the dolphins. To me it is obvious that there are no grounds for retaining the importance of a species or even a subspecies for these Azov-Black Sea dolphins.

Let us consider the arguments in support of establishing a Black Sea subspecies of the common dolphin.

I. I. Barabash (1935) described a Black Sea subspecies basing himself only on the differences in the size of the body and respectively, the skulls of dolphins of this species from the Atlantic Ocean; the Mediterranean Sea and the Black Sea. Subsequently, Barabash-Nikiforov, retaining the basic significance for the feature he had indicated earlier, adds as well some craniological differences and differences in body coloration. Analyzing these features, Barabash-Nikiforov compares that vast material which he had at his disposal on the Black Sea dolphin with singular indications in the literature on dolphins from other bodies of water. This circumstance in particular met with justifiable objections on the part of Tsalkin (1941), who noted in this regard that "detailed data on the Black Sea dolphin are compared with such scanty material from the literature on the dolphin of this species from the Atlantic Ocean that to obtain any sort of reliable representation of the nature of the existing differences is extremely difficult" (p. 176). Nevertheless, inasmuch as previous authors considered it possible to base themselves on this material in their conclusions, and I did not have the opportunity to enlarge the material on the Atlantic dolphins, then I have no choice, realizing the truth of Tsalkin's (1941) reproach, to none the less take the same course for I had nothing different at my disposal.

Let us analyze the features indicated by Barabash-Nikiforov (1940). The first of them will be the smaller dimensions of the body, and respectively, the skull of the Black Sea dolphins in comparison with the Atlantic and Mediterranean ones. *58

Silant'ev (1903), presenting 120-165 cm as the most common sizes for the Black Sea dolphin, writes that it attains 187 cm as well; and 193 cm according to data from questionnaires. E. N. Mal'm (1932), indicating a length of 100-150 cm, remarks that "specimens of the common dolphin attaining 1.75 m occur very rarely" (p. 6). A. A. Maiorova and N. N. Danilevskii (1934) consider 200 cm as a maximum length of the dolphin with a mean length of 159.8 cm for males and 156.5 cm for females. Barabash-Nikiforov (1940), on the basis of an enormous amount of material (28, 290 specimens), gives the outer bounds of the body length as 95-210 cm with a mean length of 159.9 cm. The material that I analyzed from the same expedition (which was discussed in the introduction); 38, 273 measurements for the years 1933, 1934, and 1935 (S. E. Kleinenberg, 1939), which included the material analyzed by Barabash-Nikiforov, permits the establishment of the same limits on the body length of the Black Sea dolphin with a mean length of 161.7 cm.

A. G. Tomilin (1940) determines the mean length of that dolphin as 170 cm and M. M. Sleptsov (1941) - a maximum of 205 cm. These same body dimensions, with a maximum of up to 200 cm are indicated by Freiman (1951) as well.

According to both Barabash-Nikiforov's data (1940) and that of my own, the greatest number of dolphins are 160-170 cm; only 26 specimens out of 38 thousand and some had a length over 200 cm, of which only one attained 210 cm. According to Tsalkin (1941), the maximum length of the dolphin was 219 cm.

The size of the species under present consideration, just as the sizes of the first species already examined, are characterized by various authors by different figures. But let us discard the figures presented by Silant'ev (1903) and Mal'm (1932), and we will have in mind only those data of the latter authors that are based on a very large amount of material and therefore more reliable.

Kükenthal (1889), True (1889) and others, determine the mean sizes of the Atlantic dolphins as 200-215 cm. Fischer (1881), quoting van-Beneden, presents a length of 235 cm; Flower (1883) and Trouessart (1915), indicate a size of up to 250 cm, and F. Fraser (1939), even as high as 258 cm.

As we can see, these figures point to a substantial difference in the body lengths of the Black Sea and Atlantic dolphins. We summarize them in Table 5 for a clearer presentation.

Table 5 *59

Body lengths of dolphins (in cm)

Размеры тела дельфинов (в см)

1) Водоемы	Наиболее обычные (2) размеры	Максимальные (3) размеры
(4) Черное море. .	160—170	210—219
(5) Другие водоемы	200—215	235—258

Key to Table 5:

1. Water bodies 2) Most common lengths 3) Maximum lengths

4. Black Sea 5) Other bodies of water

Let us examine the craniological differences. First of all one's attention is drawn to the difference in the size of the cranium. Thus, Silant'ev (1903) indicates dimensions of the skull of the Black Sea dolphin from 337 to 417 mm; Dinnik (1910) - from 360 to 421 mm; Mal'm (1932) presents a photograph of a cranium with a length of 360 mm; Barabash-Nikiforov (1940), on a series of 78 craniums of adult specimens, indicates figures identical to those presented by Dinnik, i.e. from 360-421 mm. Measurements which I conducted on 58 craniums of Black Sea dolphin provide figures that are very close for adult specimens; from 364-420 mm, with a mean length of the skull being 392.6 mm.

A completely different picture is observed in the sizes of the skulls of the Atlantic dolphins. Thus, True (1889) attributes skulls of 410-430 mm as not belonging to old specimens and indicates a maximum size of a skull as 467 mm. Gray (1866) presents the maximum size of a skull of this dolphin as 475 mm, and Fischer (1881), as 485 mm. Skulls of dolphins from the Atlantic and Pacific Oceans and from the Adriatic Sea, which I measured in the USSR Acad. of Sci. Zoological Museum collection, had a length of 408 mm (No. 6869), 435 mm (No. 6876) and 458 mm (No.6872). On the other hand, the maximum size of a skull of a Black Sea dolphin, indicated by Barabash-Nikiforov (1935, 1940), was 421 mm; and 420 mm according to our data. Besides, both in Barabash-Nikiforov's data as well as in ours, we had only one skull each for these measurements: in Barabash-Nikiforov's data, 197 cm in length from a specimen caught in the Novorossiisk region; and in ours, 196 cm in length from a male caught in the Yalta region in 1948 (No. 50805, in the MSU Zool. Museum collection).

Comparing the cranial proportions of dolphins from the Black Sea and other basins (the latter according to literary sources), Barabash-Nikiforov (1940) obtained indications of a somewhat greater development of the rostral section of the cranium in our dolphins" (p. 32). He illustrates this with two tables (Tables 6, 7) presented below which I supplement with our own data.

Table 6

A comparison of cranial proportions of a Black Sea common dolphin and dolphin from other water bodies (in % of the over-all length of cranium)

(From Barabash-Nikiforov, 1940, p. 32, with a supplement)

Таблица 6

Сопоставление пропорций черепа дельфина-белобочки Черного моря и других водоемов (в % от общей длины черепа)
(по И. И. Барабаш-Никифорову, 1940, стр. 32, с дополнением)

(1) Признаки	Дельфины Черного моря (*n*=8) 2	Дельфины других морей (*n*=8) 3	Дельфины Черного моря (наши данные, *n*=8) 4
5) От конца рострума до переднего края дыхала (длина лицевого отдела) . . .	72,6	70,3	72,8
6) Длина рострума	60,5	59,5	60,6
7) Ширина рострума у основания	21,0	20,3	20,5
8) Ширина рострума в его середине . . .	12,1	12,3	11,0
9) Длина нижней челюсти •	84,2	82,8	84,1
10) Длина ее альвеолярного края	49,6	49,3	49,4

Key to Table 6:

1) Features 2) Black Sea dolphin (n=8) 3) Dolphin of other basins (n=8)

4) Black Sea dolphin (our data, n=8)

5) From the tip of the rostrum to the anterior margin of the blowhole (length of facial section)

6) Length of rostrum 7) Width of rostrum at its base

8) Width of rostrum at midlength 9) Length of mandible 10) Length of its alveolar row.

Table 7

A comparison of cranial measurements of the common dolphin from the Black Sea and other water bodies (in mm). (From Barabash-Nikiforov, 1940, p. 33 with a supplement)

Таблица 7

Сопоставление измерений черепов белобочки Черного моря и других водоемов (в мм)

(по И. И. Барабаш-Никифорову, 1940, стр. 33, с дополнением)

1) Признаки	Дельфины Черного моря (*n*=8) 2	Дельфины других морей (*n*=8) 3	Дельфины Черного моря (наши данные, *n*=8) 4
5) Общая длина	405	408	409
6) От конца рострума до переднего края дыхала (длина лицевого отдела)	294	287	298
7) Длина рострума	245	243	248
8) Ширина рострума у основания	85	83	84
9) Ширина рострума в его середине	49	50	45
10) Длина нижней челюсти	341	338	344
11) Длина ее альвеолярного края	201	201	202
12) Зубная формула	$\frac{40\text{—}48}{41\text{—}50}$	$\frac{39\text{—}49}{42\text{—}50}$	$\frac{40\text{—}42}{39\text{—}48}$
13) Длина тела в см	160—197	153—183	176—196

Key to Table 7:

1) Features 2) Black Sea dolphin (n=8) 3) Dolphin of other basins (n=8)

4) Black Sea dolphin (our data, n=8) 5) Over-all length

6) From the tip of the rostrum to the anterior margin of the blowhole (length of facial section) 7) Length of rostrum

8) Width of rostrum at its base 9) Width of rostrum at midlength

10) Length of mandible 11) Length of alveolar row of mandible

12) Tooth formula 13) Length of body in cm.

In both tables our figures come closer to Barabash-Nikiforov's figures (1940) characterizing the dolphins of the Black Sea than they do to the data on dolphin from other water bodies in spite of the fact that in Table 7, regarding the first feature, i.e. the total length, I *61 was able to select skulls which displayed a mean dimension almost the same as that given for dolphin from other bodies of water. Nevertheless, in both tables a more or less substantial difference between skulls of the dolphins from the Black Sea and other bodies of water is observed (as Barabash-Nikiforov correctly notes) only in the measurements of the rostral section of the cranium, i.e. in the length of the facial section and in the length of the mandible. The remaining measurements do not show any substantial differences.

A comparison of cranial proportions of the dolphin from the Black Sea and other bodies of water were conducted by me in Table 8 presented below. Three skulls of Black Sea dolphin from the USSR Academy of Sciences Zoological Musuem collection, whose dimensions and inventory numbers were indicated above, served as material for the Table. Three of the largest skulls according to size were selected from our material on the Black Sea dolphin for the comparison. Nevertheless, even despite such a special selection, we were unable to obtain a mean dimension corresponding to a mean dimension of a skull of a dolphin not from the Black Sea because of the considerably larger dimensions of the skulls from the collection of the USSR Acad. of Sci. Zool. Musuem compared with the Black Sea skulls. Therefore, it was necessary to express the skull measurements in percentages to the total length of the skull and not in absolute figures, for in the latter case we would have obtained entirely incomparable data. The Table contains data on all of the measurements which I employed in measuring the skulls.

Very close figures were obtained on the majority of the 50 features presented.

The difference which was being obtained in the length of the facial section in the last two tables is unnoticeable in the latter one, and the length of the rostrum in the dolphin from the other bodies of water as well as in the length of the mandible turns out as though it was even a little greater than in the Black Sea dolphins. The differences in these two features in Table 8 agree nicely with the difference in length of the upper and lower alveolar margins, and the last two features agree in turn the differences in the number of teeth in the upper and lower jaws. A considerable difference is observed in the length of the symphysis as well. Moreover, Table 8 gives some differences in the width measurements of the rostrum.

It should, of course, be admitted that the material for comparison which was at my disposal was so small that it is impossible to make any definite conclusions whatsoever on the craniological differences observed between the dolphins of the Black Sea and other bodies of water, the more so if we keep in mind the great variability of the cranium on which we will dwell below. I am aware of the fact that on a large series [of skulls - Trans.] the differences appearing in Table 8 could turn out to be illusory.

Nevertheless, it should be emphasized that in making a comparison on the basis of the same insignificant amount of material concerning other Black Sea species with the same species from other bodies of water, we do not obtain any differences. With regard to the harbour porpoise, this was already demonstrated, while concerning the bottle-nose dolphin, this will be demonstrated later on.

Таблица 8

(1) Сопоставление пропорций черепа белобочки Черного моря и других водоемов

(в % от общей длины черепа)

	(2) Признаки	3 Среднее для 3 черепов дельфинов Черного моря	4 Среднее для 3 черепов дельфинов других водоемов
5	Общая длина черепа в мм	417	434
6	Основная длина черепа	98,4	98,4
7	Длина лицевого отдела	73,0	73,2
8	Длина мозгового отдела	27,0	26,8
9	Длина рострума	61,3	62,1
10	Ширина рострума у основания	20,0	21,1
11	Ширина рострума у последнего зуба	13,8	15,2
12	Ширина рострума в его середине	11,5	12,4
13	Высота рострума у последнего зуба	8,1	8,8
14	Длина верхнего альвеолярного края	50,1	51,6
15	Длина межчелюстных костей, наибольшая	83,4	83,6
16	Длина основной кости	16,3	16,4
17	Длина преддыхала	11,7	11,1
18	Расстояние от нижнего края затылочного отверстия до крыловидных костей по средней линии	28,8	28,6
19	Расстояние от нижнего края затылочного отверстия до заднего края альвеолярного ряда по средней линии	46,1	46,3
20	Расстояние от затылочного гребня до конца рострума по средней линии	88,9	88,8
21	Расстояние от носовых костей до конца рострума по средней линии	84,3	84,8
22	Расстояние от переднего края височной впадины до переднего края лобной кости	21,5	21,1
23	Длина височной впадины	16,6	15,3
24	Высота височной впадины	11,1	11,7
25	Длина затылочного гребня по прямой	35,8	36,8
26	Длина затылочного гребня лентой	47,2	46,9
27	Косая: от нижнего края затылочного отверстия до заднего края височной дуги	28,5	27,6
28	Косая: от середины крыловидных костей до переднего края височной дуги	21,0	21,4
29	Наибольшая высота черепа	36,2	35,3
30	Наибольшая высота затылочной области	30,3	30,9
31	Наибольшая ширина черепа	41,9	42,1
32	Наибольшая ширина мозговой коробки	35,0	33,6
33	Межглазничная ширина, наименьшая	37,1	37,5

Таблица 8 (продолжение)

Признаки	Среднее для 3 черепов дельфинов Черного моря	Среднее для 3 черепов дельфинов других водоемов
34 Ширина межчелюстных костей в середине рострума	5,0	5,7
35 Наибольшая ширина черепа в передней части лба	37,3	38,9
36 Ширина развилки межчелюстных костей, наибольшая	17,3	17,0
37 Поперечный диаметр дыхала	10,6	9,9
38 Ширина птеригоидного отверстия	12,4	12,9
39 Длина птеригоидного отверстия	12,6	12,3
40 Кондилярная ширина	19,8	20,6
41 Кондилярная высота	11,8	11,7
42 Ширина зуба в середине верхней челюсти, в мм	3,0	3,0
43 Частота зубов на протяжении 2,5 см в середине верхней челюсти	5,0	5,3
44 Количество зубов в верхней челюсти	82	94
45 Количество зубов в нижней челюсти	88	96
46 Длина нижней челюсти	84,7	86,1
47 Длина нижнего альвеолярного края	49,6	52,4
48 Ширина основания нижней челюсти	15,5	14,9
49 Расстояние от вырезки у мыщелка нижней челюсти до ее переднего края	81,9	83,0
50 Расстояние от мыщелка нижней челюсти до заднего края ее альвеолярного ряда	35,9	34,4
51 Расстояние от мыщелка нижней челюсти до переднего края вырезки на внутренней стороне челюсти	26,3	25,5
52 Наименьшая высота нижней челюсти	3,5	3,6
53 Высота нижней челюсти позади задних крайних зубов	7,6	7,8
54 Длина симфизиса	9,9	12,0

Key to Table 8:

1. Comparison of skull proportions of the common dolphin from the Black Sea and other bodies of water (in % of total length of skull).

2) Features 3) Mean for the three skulls of the Black Sea dolphin

4) Mean for the 3 skulls of dolphin from other basins

5) Total length of cranium in mm 6) Basic length of cranium

7) Length of facial section 8) Length of cerebral section

9) Length of rostrum 10) Width of rostrum at its base

11) Width of rostrum at the last tooth 12) Width of rostrum at midlength

13) Height of rostrum at last tooth 14) Length of upper alveolar margin

15) Length of premaxillaries, greatest 16) Length of basilar process

17) Length of prenarial triangle

18) Distance between the inferior margin of the foramen magnum and the pterygoids along a median line

19) Distance from the inferior margin of the foramen magnum to the posterior tip of the alveolar row along a median line

20) Distance from the occipital crest to the tip of the rostrum along a median line

21) Distance from the nasal bobes to the tip of the rostrum along a median line

22) Distance from the anterior margin of the temporal fossa to the anterior edge of the frons

23) Length of temporal fossa 24) Height of temporal fossa

25) Length of the occipital crest in a straight line

26) Length of the occipital crest with a tape

27) Diagonal: from the inferior margin of the foramen magnum to the posterior tip of the temporal arch 28) Diagonal: from the center of the pteryogoids to the anterior edge of the temporal arch

29.Greatest height of cranium
30.Greatest height of occipital region 31. Greatest breadth of cranium
32. Greatest breadth of the braincase
33. Interorbital breadth, the smallest
34. Width of premaxillaries in the middle rostrum *63
35. Greatest width of the cranium in the anterior section of the frons
36. Width of the bifurcation of the premaxillaries, the greatest
37. Transverse diameter of the blowhole
38. Width of the pterygoid foramen
39. Length of the pterygoid foramen
40. Condylar width
41. Condylar height
42. Width of tooth in the middle of the maxilla in mm
43. Frequency of teeth in a 2.5 cm length in the middle section of the maxilla
44. Number of teeth in the maxilla
45. Number of teeth in the mandible
46. Length of mandible
47. Length of lower alveolar margin
48. Width of the base of the mandible
49. Distance from the notch at the mandibular condyle to the anterior tip of the mandible
50. Distance from the condyle of the mandible to the posterior edge of its alveolar row
51. Distance from the posterior edge of the mandibular condyle to the anterior margin of the notch on the interior side of the mandible
52. Smallest height of the mandible
53. Height of the mandible behind the last back teeth
54. Length of the symphysis.

As I have already said, it is necessary to have at one's disposal a larger series (of skulls in this instance) for any sort of conclusions of the systematic order concerning the small cetaceans, since the range of individual, sex and age variability in all of the dolphins is extremely broad.

There is a very clearly defined work on the variability of the cranium in the common dolphin done by I. F. Tryuber (1937) which eases my task considerably, the more so since our material only confirm her data. *64

The author had at her disposal a series of 70 skulls of the common dolphin collected by the VNIRO expedition, i.e. the same series used by Barabash-Nikiforov (1940) and which formed the basis of my measurements of the skulls of this species of dolphin. Tryuber took 32 measurements on each skull.

Before turning to the variability of the cranium, I will take the liberty of mentioning that these changes and growth in the cranium of all three Black Sea species proceed basically in an analogous manner, and therefore, after having demonstrated the age changes in the cranium using the common dolphin as an example, I will not be returning to this issue later on.

Tryuber (1937) correctly characterized the age changes occurring in the cranium of the common dolphin with the following words: "In the first year of life, the sutures close, the beginnings of the crests are formed and eruption of the teeth [i.e. dentition - Trans.] begins. Yearlings already have well developed teeth. The intensified function of the maxillary apparatus with the transition to independent feeding later causes an intensified growth of the crests, angular processes and protuberances (areas of muscle attachment), the roundness of the cranium and the conspicuousness of the sutures disappear, the relationships of the cranial sections to each other change - a lengthening of the facial and rostral sections to each other change - a lengthening of the facial and rostral sections occurs; the maximum breadth of the cranium shifts to the region of the zygomatic processes. With the approach of full maturity, the growth of the cranium is basically completed, and later on, only certain detailed changes occur (increase in the height of the crests, magnitude of processes and others" (p. 21).

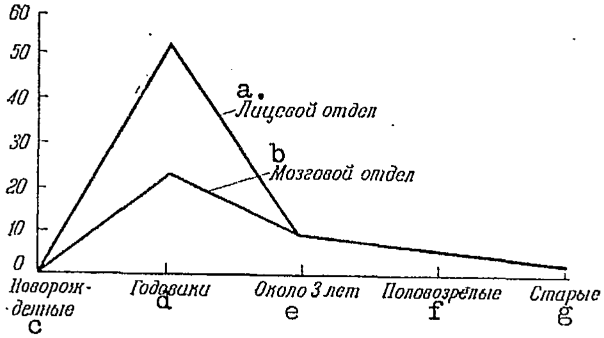

Рис. 12. Кривые роста черепа белобочки (прирост в процентах к величинам предыдущей группы) (по И. Ф. Трюбер).

Fig. 12. Growth curves of the white-sided dolphin cranium (increase in percentages to the size of the preceding groups) (From I. F. Tryuber)

<u>Key to Fig. 12</u>: a) Facial section b) Cerebral section c) Newborn d) Yearlings e) About 3 years f) Fully mature g) Old individuals

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Consequently, the increase in the total length of the cranium proceeds mainly due to the growth of the facial section, which is nicely illustrated in Figs. 12 and 13.

Concerning sexual dimorphism Tryuber (1937) notes: "Features of sexual dimorphism in the craniums of D. delphinus ponticus do not appear as absolutes, but in a form of a general tendency of 'average types'." Further: "The sexual differences consist mainly of the following: the length of the cranium relative to the length of the body in males is smaller than in females. The facial section in males is bigger than in females; the cerebral section, on the contrary, is shorter and higher and wider besides. The rostrum in the males is shorter than in the females, but is wider and higher as well. The mandible in the males and females is of equal length, but higher and wider than in the females. Thus, the entire rostral section with the jaws closed has a shape of a blunt, broad wedge in the males, while in the females this formation is more pointed and lengthened" (pp. 23-24). *65

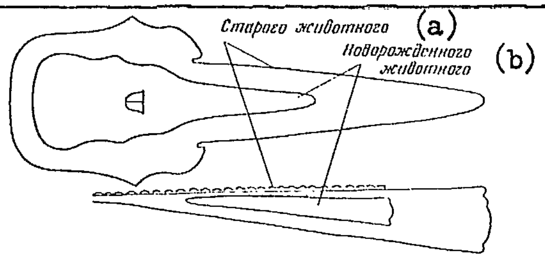

Рис. 13. «Контуры наложения» черепов белобочки. Нижний рисунок — нижняя челюсть (по И. Ф. Трюбер).

Fig. 13. "Contours of superimposition" in skulls of the common dolphin. Bottom illustration - mandible (From I. F. Tryuber)

Key to Fig. 13: a) Old individual b) Newborn animal

Unfortunately, Tryuber confines herself only to a statement without presenting any figures. This situation deprives us of the opportunity of comparing the figures she obtained with ours. Therefore I will present Table 9 that I complied on those features which Tryuber (1937) notes. *66

Table 9

Comparison of cranial proportions of adult male and female Black Sea common dolphin. (in % to the total length of the cranium).

Таблица 9

Сопоставление пропорций черепа взрослых самцов и самок дельфина-белобочки Черного моря

(в % к общей длине черепа)

1. Признаки	2. Средние для самцов (n = 23)	3. Средние для самок (n = 11)
4. Общая длина черепа в мм	394	383
5 Отношение длины черепа к длине тела в %	22,0	22,3
6 Длина лицевого отдела	72,3	71,7
7 Длина мозгового отдела	27,7	28,3
8 Высота затылочной области	31,6	31,2
9 Ширина мозговой коробки	35,7	35,5
10 Длина рострума	60,2	60,2
11 Ширина рострума у основания	21,0	20,6
12 Высота рострума у последнего зуба	8,0	7,7
13 Длина нижней челюсти	84,7	84,7

Key to Table 9:

1) Features 2) Mean for males (n=32) (3) Mean for females (n=11)

4) Over-all length of skull in mm (5) Ratio of cranial length to the length of the body in %. (6) Length of facial section (7) Length of cerebral section (8) Height of the occipital regiom (9) Breadth of braincase

(10) Length of rostrum (11) Width of rostrum at its base

(12) Height of rostrum at the last tooth (13) Length of mandible

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As can be seen from the table, sexual dimorphism is exhibited first of all in the absolute size of the cranium and in the relative length of the facial and cerebral sections. It is in these features in particular that sexual dimorphism was exhibited to a greater degree in the first species that we have already examined as well. Nevertheless, in the present case dimorphism is observed in an inverse relationship, i.e. while the absolute size of the cranium in the males is smaller than in the females in the harbour porpoise, in the common dolphin, on the contrary, the absolute size of the skull in the common dolphin males is greater than in the females which is caused of course by the differences in size of the animals of different sexes.

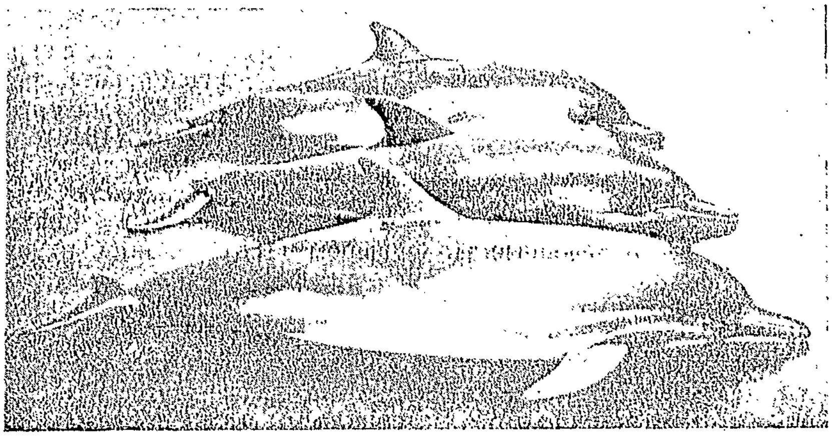
As was demonstrated above, the cranium grows mainly as a result of the facial section; consequently it is the length of the facial section that determines the overall length of the cranium; a fact that is confirmed by Table 9 as well.

As for the remaining features indicated by Tryuber (1937), even though they are present, the differences in this case between the males and females are so insignificant that even "in view of a general tendency towards average types" they are almost indiscernable.

Individual variability of the cranium in the common dolphin is extremely marked. Such features as the height of the foramen magnum, its width, the dimensions of the temporo-parietal fossa, the length of the basilar process, height of the rostrum, the number of teeth, vary the most. Interorbital breadth, the width of the blowhole, the width indices of the rostrum, vary to a lesser degree, and to a still lesser degree - the variation in the length of the rostrum, the alveolar margins, the premaxillaries, the mandible, the facial and cerebral sections. Finally, individual variability to a small degree affects such features as the overall length of the cranium, its basic length and the height of the occipital region.

As a result, the exact same features whose variations were noted in the analysis of the first species above, changed the most. Such individual variability is observed in the craniums of the third species as well. Therefore, during the analysis of the material on the bottle-nose dolphin, I will not be touching upon the individual variability of the cranium in this dolphin.

Let us return to the features which served as a basis for Barabash-Nikiforov's (1940) establishment of a Pontic subspecies of the common dolphin. Two of them - the difference in size of the animals and craniological differences - have already been analyzed above. As a third feature, the author used the coloration of the body of this dolphin, meaning the differences in the distribution of color fields and bands of various *67 shades under the term coloration. It should be noted that the pigmentation of the common dolphin differs greatly from that of other Black Sea dolphin.



Origin

Рис. 14. Окраска тела белобочки (оригин.).

Fig. 14. Body coloration of the common dolphin (origin.)

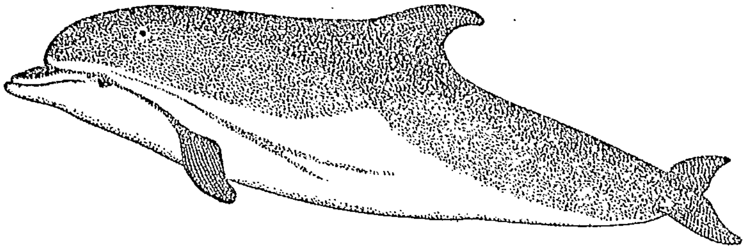


Рис. 15. Окраска тела белобочки (по И. И. Барабаш-Никифорову).

Fig. 15. Body coloration of the common dolphin (by I. I. Barabash-Nikiforov).

Being made up basically of only white and black colors, it exhibits a band of varying shapes and varying degrees of transitions from one color to another on the flanks of the body of the animal. Because of this the flanks of the body of the dolphin have a unique pattern of various shades of grey, black and white colors (Figs. 14 and 15).

Having worked out a method of filling in these outlines of fields and bands varying in shape and color, Barabash-Nikiforov (1940) obtained sketches of the coloration of a large number of Black Sea dolphin. Comparing this material with a description and sketches of the coloration of the Atlantic dolphin, Barabash-Nikiforov (1935) does not recognize this feature as having differential significance. He writes: "The coloration *68 of the body approaches the description given by True and other authors but differs somewhat from the one Flower depicted in a sketch (from a specimen from the Atlantic Ocean)...It is difficult so far to say how constant the coloration depicted by Flower is, and to what extent it is comparable with the coloration of our dolphins" (p. 248). In a subsequent work, Barabash-Nikiforov (1940), comparing his sketch with Flower's sketch and also that of Kükenthal (1909), already finds definite differences in the coloration of the body in the Black Sea and Atlantic dolphins. However, that is not the point of the matter. Introducing for comparison sketches of color variation of dolphins presented by Fischer (1881) and having in mind the sketches of the Atlantic dolphins cited above, Barabash-Nikiforov (1940) establishes considerable variation in this feature in the Atlantic dolphins. In the Black Sea dolphins, on the other hand, the author considers body coloration to be highly constant, a fact that he emphasizes time and again. Thus he writes: "With the aid of this material, we established that the coloration of the body (i.e. the pattern on the body; not to be confused with color) in our dolphins is one of the most constant features, subject only to the most insignificant fluctuations" (p. 34). "The high constancy of the feature of coloration forces us to concern ourselves with the presented facts with more attention. Indeed, we have two clearly designated groups of dolphins according to the degree of variability in the coloration: dolphins of the Black Sea, exhibiting almost no variation in this feature, and dolphins from other seas, which, judging by all of the data, are subject to extreme variability in coloration" (p. 35). Together with these affirmations, in the same work - on p. 50 - Barabash-Nikiforov presents six types of colorations, differing substantially from one another in the Black Sea dolphin. It is true that in presenting these sketches, the author strives to demonstrate the heterogeneity of the Black Sea common dolphin population. However, the most remarkable thing of all, is the fact, as one can see from Fig. 16, that dolphins from the exact region of the Black Sea vary considerably in their color. Thus Barabash-Nikiforov himself refutes his own claim regarding the constancy of the feature of coloration in the Black Sea dolphin, easing my task by doing so. I will note that during my work on the Black Sea, many tens of thousands of dolphin of this species passed through my hands, on the basis of which I can indicate the presence in it of a high variation in this feature. As a result, the third feature distinguished by Barabash-Nikiforov (1940) as a differential feature in the description of the Black Sea subspecies of the common dolphin, in contrast to the first two features, one can recognize as unfounded. *69

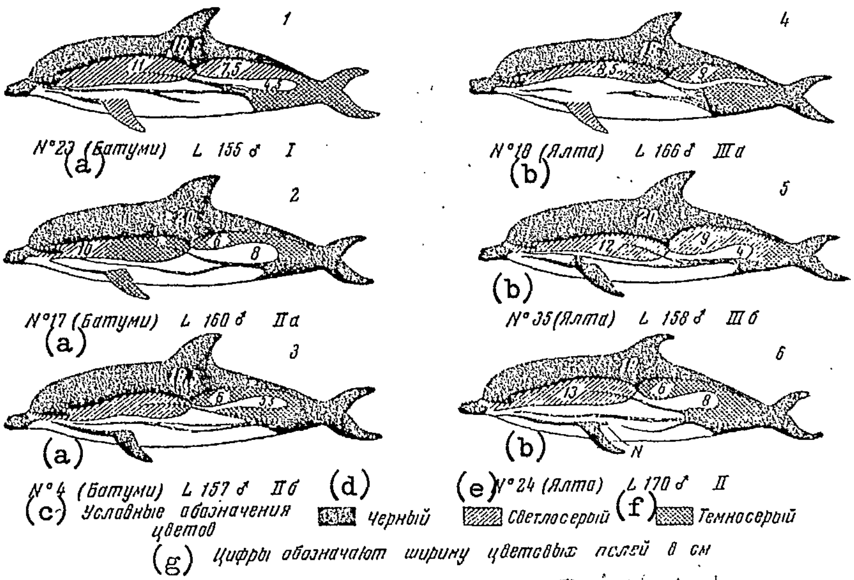


Рис. 16. Вариации в окраске тела белобочки
(по И. И. Барабаш-Никифорову).

Fig. 16. Variation in body color in the common dolphin (by Barabash-Nikforov)

<u>Key to Fig. 16</u>: a) Batumi b) Yalta c) Conventional representation of colors d) Black e) Light grey f) Dark grey g) The figures indicate the width of the color fields in cm.

Despite this, and taking into consideration the substantial difference in the size of the animals, as well as certain craniological diferences, contrary to my own earlier mistakenly expressed opinion (S. E. Kleinenberg, 1951), I consider it necessary to retain the importance of a subspecies for these Black Sea dolphin.

Let us examine the arguments presented by Barabash-Nikiforov in support of the existing, in his opinion, systematic heterogeneity of the Black Sea population of the common dolphin. As was already noted earlier, Barabash-Nikiforov (1938), on the basis of a biometric analysis of the catches of dolphin in the Batumi and Yalta-Novorossiisk regions, came to the conclusion that in the Black Sea there exist two races of common dolphin: the north-eastern and south-western. Later on, Barabash-Nikiforov (1940) renounced this concept and as an explanation for the differences between the Batumi and the Yalta-Novorossiisk dolphins which he obtained he advanced "a no less probable hypothesis of a different order" (p. 53), and in particular: "We admit the Pontic subspecies D. delphis does not *70 establish within its composition lower taxonomic units but is subject to partial merging with individuals of D. delphis coming in from the Mediterranean Sea" (p. 53). Inasmuch as the author himself renounced his original hypothesis regarding the existence of lower taxonomic units within the common dolphin population in the Black Sea, this spares me the necessity of dwelling on this issue.

Developing his second hypothesis, Barabash-Nikiforov considers the Batumi dolphin carriers of a "purer (typical) features of the Pontic subspecies of D. delphis" (p. 54). On the other hand, the affects of contamination in the catches by the Mediterranean individuals shows up, in his opninin, in the north-eastern section of the Black Sea. But here, questions automatically arise, which were correctly posed by Tsalkin (1941).

In the first place: why do the Mediterranean dolphin, penetrating into the Black Sea, so stubbornly avoid the Batumi waters? And in the second place: if one assumes that in the catches in the Yalta-Novorossiisk region a considerable number of Mediterranean individuals are present (since an insignificant number could not have given differences in a biometric analysis), in what way are these supposedly definite differences between the Black Sea and Mediterranean dolphins obtained, on the basis of which a Pontic subspecies is described? These questions remain unanswered.

In support of his hypothesis Barabash-Nikiforov (1940, p.55) presents the following quotation from Mal'm's work (1938): "There exists an Anatolian race of dolphin in the Black Sea - the 'black-moustached' - which perhaps is a result of the hybridization near the Anatolian shores of the Mediterranean dolphin with the Pontic form. This race migrates by means of the shortest route from Ineboli to the region of the Crimea... On the other hand, there exists a Pontic race, inhabiting earlier the area near the shores of the Crimea and the Caucasus, and to a considerable degree exterminated by the commercial industry and forced back at the present time to the Caucasian shores by the Anatolian dolphin" (p. 70). And a little earlier in the work, Mal'm writes: "There are no grounds for dividing the Black Sea dolphin into races within the regions of the USSR, and it is difficult to believe that the dolphin, an animal with a large ecological valence, should be restricted in its movements to certain regions of the sea, in spite of the fact that the water area of the Black Sea is generally small" (p. 70). It is difficult to find another example where such contradictory statements could belong not only to the same author, but could be found in the same work and even on the very same page.

Mal'm's (1938) statements on this issue don't deserve to be quoted. *71

What then were these features that gave Barabash-Nikiforov (1938, 1940) the basis for speaking of the differences between the "south-eastern" and "north-eastern" dolphins? These features consist of the following: 1)differences in the body dimensions: in the north-eastern group, the length of the body, according to the author's data, is on the average 160 cm, and 155 cm for the south-eastern; 2) a difference in body coloration; 3) a very insignificant difference in body proportions.

As to the third feature, it is unconvincing because the author, presenting a very large amount of material, compares the body proportions of larger "north-eastern" dolphins with smaller "south-eastern" ones. Thus, these differences in body proportions which Barabash-Nikiforov obtained can be conditioned by other dimensions of the animal, the more so since he presents body proportions of animals of different lengths using the harbour porpoise and bottlenose as an example, and where differences in body proportions by no means smaller than those obtained between the "north-eastern" and "south-eastern" common dolphin clearly emerge. If Barabash-Nikiforov had compared animals of the same length from various regions, then the situation with the third feature would have been different. However, this had not been done.

Concerning the invalidity of the second feature, i.e. the difference in color, I have already discussed it earlier.

As to the first feature, i.e. the smaller body dimensions of the Batumi dolphins in comparison with the Yalta-Novorossiisk ones, I have no grounds for suspecting it since Barabash-Nikiforov's data (1940) were based on a vast amount of material. On the other hand, it is impossible to agree with Tsalkin's (1941) counter agrument, who explains this by the fact that in Batumi region the harpoon-rifle method is predominantly stressed while in the Yalta-Novorossiisk region it was seine netting, and that the harpoon-rifle method generally utilizes animals smaller in dimension than does seine netting, since Barabash-Nikiforov (1938, 1940) had at his disposal animals from the seine netting activities in the Batumi region as well. In addition, Mairova and Danilevskii (1934) indicated smaller body dimensions of the "southern" dolphins as well, who, while comparing the animals only from the seine netting activities present the following mean dimensions of the dolphin: in the Yalta-Adler region - 159.8 cm for males and 156.6 cm for females; 153.7 cm for males and 150.5 for females in the Pitsunda-Sukhumi region. As a result, there is no doubt that dolphin of smaller dimensions are taken commercially near the Adzharistan and Abkhazia coasts.

*72 Nevertheless, the explanations for this fact advanced by Barabash-Nikiforov (1938, 1940) and Mal'm (1938) clearly are not convincing and require reconsideration.

In the years 1934, 1935 and 1939, I had to study the catching of dolphin in the Adzharistan, Abkhazia and Tuapse regions, sailing together with a large numbers of brigades of commercial dolphin fishermen (S. E. Kleinenberg, 1941), during which time, in 1934, I moved with the brigade at the completion of the commercial season in one region to its commencement in the next. In Batumi, commercial dolphin whaling which began in January, ended in April due to the lack of dolphin. With the completion of the activities in Batumi, they resumed in Sukhumi. With the completion of the commercial activities here, we moved on to Novii Afon, then to Pitsunda, to Gagry and finally to Adler. Towards July, the commercial activities in the south-eastern section of the Black Sea ended completely and the entire industry was then concentrated in the Tuapse, Novorossiisk and Yalta regions. The average sizes of the dolphin caught in all of the localities of the south-eastern section of the Black Sea were very close, both as regards the sizes among the localities themselves, and to the sizes indicated by Maiorova and Danilevskii (1934) and Barabash-Nikiforov (1940). They were expressed in figures ranging from 150 to 157 cm.

Hence, I arrived at a quite definite conviction that the dolphins, passing the winter near the Batumi shores, migrate along the coast to the north in the spring and toward summer and reach the principal area of concentration of dolphins in the north-eastern section of the sea.

The second factor, which I can attest to, is the fact that the commercial activities, both in the region of Adzharistan and in the Abkhazia regions, were always conducted not more than 10 miles offshore, while in the north-eastern section the brigades ranged considerably farther out into the sea.

From a recently published work by M. N. Tarasevich (1951), we know that schools of dolphin are usually differentiated according to sex and age.

The phenomenon of such a differentiation within schools is fairly widely prevalent among marine mammals and was noted by me earlier in connection with the Caspian seal as well (S.E. Kleinenberg, 1939a).

Taking all of the above into consideration, I am therefore inclined to think that schools of dolphin composed of younger (and therefore, smaller in size as well), mainly not as yet fully sexually mature individuals, pass the winter in the vicinity of the Batumi shores and migrate along the coast northward and toward summer, reach the north-eastern area of the main concentrations of dolphin. This in particular, in my view, explains the differences in the body dimensions of the "south-eastern" and "north-eastern" dolphins.

This seems to me more probable than the hypotheses suggested in this regard by Barabash-Nikiforov (1938, 1940) and Mal'm (1938). *73

Let us analyze the taxonomic status of the third species of the Black Sea dolphin - the bottle-nose dolphin.

Barabash-Nikiforov (1940) basis his relegation of this dolphin to a Pontic subspecies on the following features:

1) somewhat smaller body dimensions compared with the Atlantic individuals:

2) a somewhat different nature of the distribution of color;

3) a shortened rostrum which is wider at the base and narrower in the middle;

4) fewer teeth

Let us analyze these features in the same order as they were presented by the author.

The following dimensions (length of the animal) for the Mediterranean and Atlantic bottle-nose dolphins are indicated in the literature; from 235 to 310 cm - Fischer (1881), based on five specimens; 300 to 310 cm -

Trouessart (1910) (maximum dimensions); 310 to 330 cm - Fruend (1932).

For the Black Sea population, Barabash-Nikiforov (1940) indicates the limits as 120 to 310 cm, with a mean length of 225.15 cm, based on 1450 specimens. Tomilin (1940) presents a mean length of 240 cm and Freiman (1951), a maximum length of 300 - 310 cm. Our materials of 50 specimens gives the maximum dimensions of 155 to 310 cm, with a mean length of 274.9 cm for adult males, and 233.1 cm for adult females. From a comparison of all of these figures, a conclusion diametrically opposed to the one Barabash-Nikiforov (1940) drew suggests itself, i. e. that there is no difference (such as the one, for example, observed for the preceding species) in the body dimensions of the bottlenose from the Black Sea and other bodies of water.

The maximum figure of 330 cm indicated by Freund (1932) does not disturb me, since I am completely convinced that the figure of 310 cm obtained by Barabash-Nikiforov (1940) and myself does not represent the maximum size of the Black Sea form. In the example of the common dolphin, it should be recalled, that in order to record the maximum dimensions of this dolphin on the basis of only one specimen, it was neccessary to survey over 25 thousand animals; in the present case, it is significant that on the basis of our considerably small material, the very same maximum of 310 cm revealed which Barabash-Nikiforov (1940) indicates from 1450 specimens. Apart from this consideration, my certainty is corroborated by a fact communicated to me by the former director of the Yalta fish plant, I. M. Maskin. In the spring of 1946, commercial fishing brigades discovered such a large concentration of the bottle-nose dolphin near the Yalta coast that more than 3 thousand animals were caught in one day.

Maskin measured about ten of the largest animals with a tape measure. Among them were several specimens attaining 3.3 m in length, according to Maskin's communication.

Thus, I cannot consider the first feature indicated by Barabash-Nikiforov (1940) as differential for establishing the Pontic subspecies of bottlenose as actually existing.

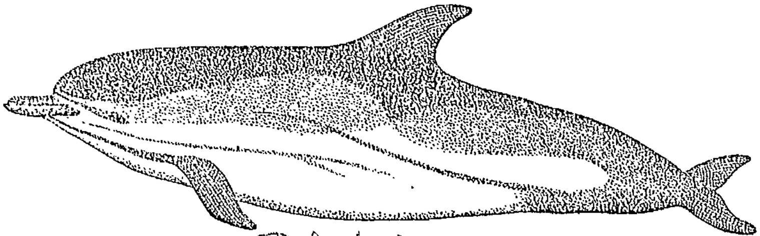


Рис. 17. Черноморская ~~афалина~~ Delphinus (по И. И. Барабаш-Никифорову).

Fig. 17. Black Sea bottle-nose dolphin (by I. I. Barabash-Nikiforov).

The arguments which Barabash-Nikiforov (1940) presented in support of the existence of a second feature correspond to the ones he presented for the preceding species as well, i.e. the common dolphin. However, inasmuch as the author attaches differential significance to that feature in the description of the Pontic subspecies of the bottlenose as well. I am obliged to dwell on this feature in the present case also.

Presenting an illustration of this dolphin (see Fig. 17), Barabash-Nikiforov (1940) writes: "The color of the Black Sea bottle-nose dolphin is very constant..." (p. 60), and farther: "On closer study of the color of our bottle-nose dolphin, we discover a pattern on its body very similar to the one described for D. delphis above" (p. 60).

We do not find indications of a similar differentiation in color in any one of the descriptions by foreign authors. Fischer (1881) defines the color of the dolphin under discussion as an intense black throughout the entire body with the exception of a narrow ventral band; light grey in the males and white in the females (we were unable to observe any sex differences in color, nor do we find any confirmation of this fact in descriptions by foreign authors). True (1889) characterizes the color of the form under discussion differently. According to this author, the color of the back of T. truncatus is lead-grey with a slight tinge of *75 of purple. The flanks are lighter and gradually turn pure white in color on the ventral aspect. True notes that some isolated specimens have a uniform grey color. In Flower's illustration (1880), the grey-black pigmentation of the dorsal aspect turns into a grey color on the flanks and the latter borders abruptly with the white color of the abdomen. Similar to that description is an illustration of a young specimen by Kükenthal (1909), but the grey color of the flanks blends into the white ventral pigmentation with a greater graduation. We can thus contrast the extremely constant and characteristic color of the Black Sea individuals of T. truncatus, apparently, with the highly varying color of individuals from other seas" (pp. 60-61).

I will present some of my own photographs of the Black Sea bottlenose dolphins taken in 1948 in Yalta. Depicted in the first of these (Fig. 18), are: in the foreground - a common dolphin; and farther on, two bottle-nose dolphins (lying in front is a one-and-one-half meter tape). As we can see, the color of the bottlenose bears no resemblance to either the common dolphin or the color of the bottlenose (see Fig. 17) which

Barabash-Nikiforov gave (1940). If I am met with objections to the effect that the camera does not capture those shades which are captured by the human eye "on a closer study of the color", then I am within my rights to answer that with the question: why did the camera capture those shades on the common dolphin, and not capture them on the bottlenoses lying alongside?

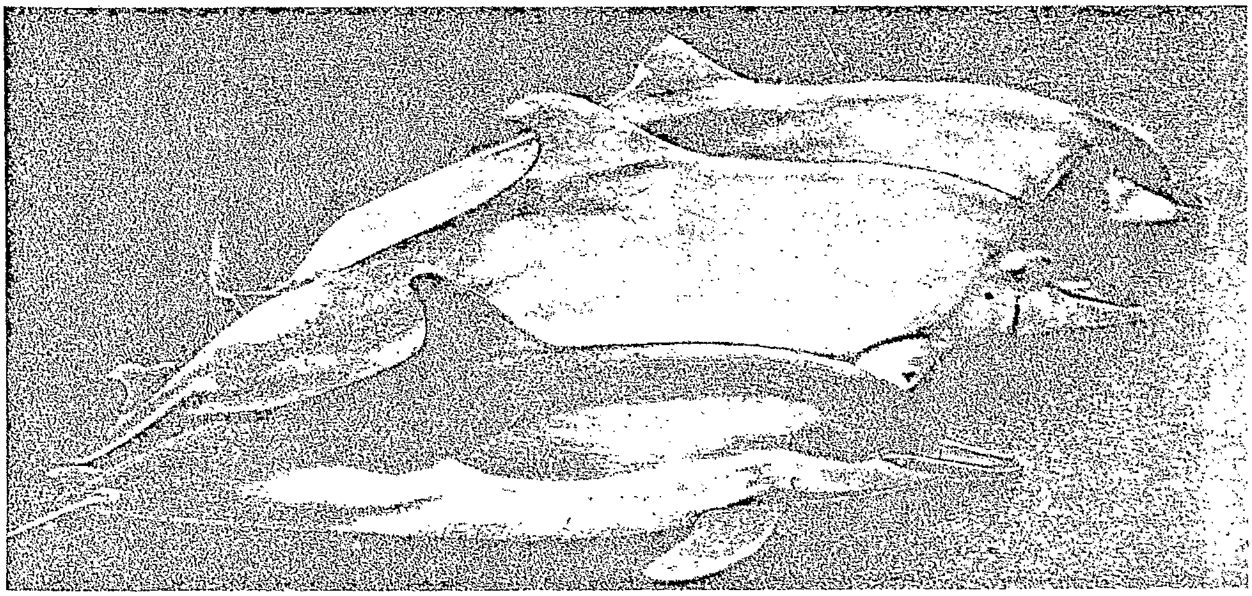


Рис. 18. Белобочка (на переднем плане) и две афалины (оригин.).

Fig. 18. A common dolphin (in the foreground) and two bottlenose dolphins (origin.).

On the following photograph (Fig. 19), the ventral aspects of four bottlenoses are depicted. In the specimen lying in the foreground, the intense grey or almost black color extends as far as the anus on the ventral aspect, and the anterior section of the ventral aspect and the mandible are of a grey color. In the second and fourth specimens, on the other hand, the ventral aspect, beginning from the mandible, is pure white in color which extends even as far as the caudal peduncle.

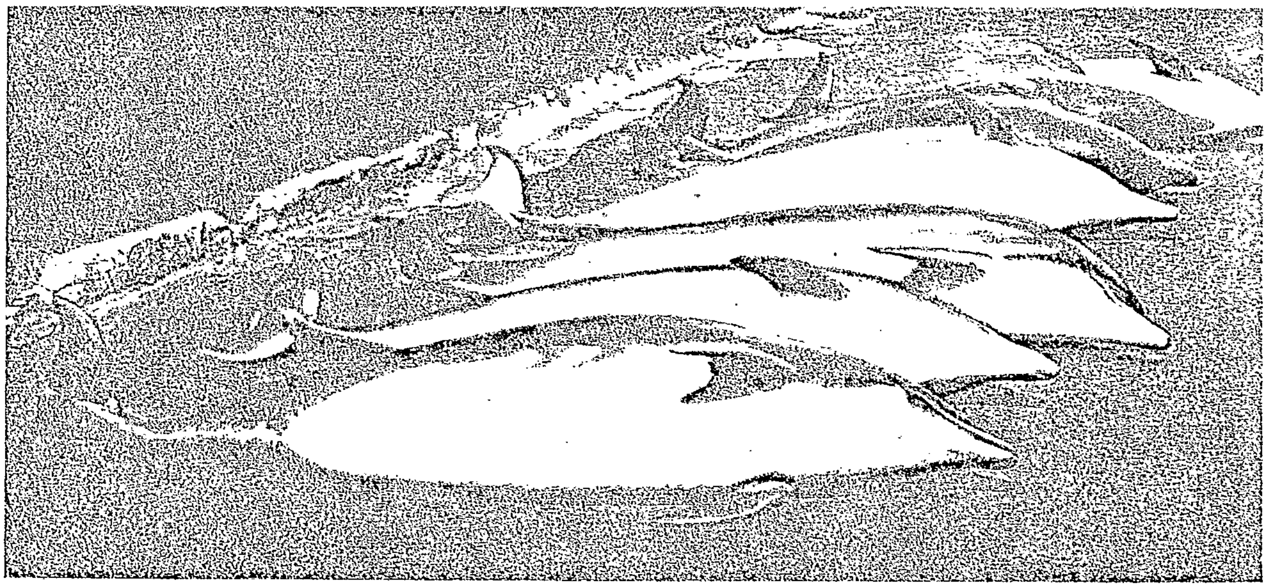


Рис. 19. Вариации в окраске тела черноморской афалины (оригин.).

Fig. 19. Variation in body color in the Black Sea bottlenose dolphin (origin.).

Even the intensity of the basic tone of the color of the animal varies. Thus in Fig. 18, the bottlenoses are of a light grey color, while in Fig. 20 - a dark grey, almost black pigmentation. Here, exceptions may be taken to the effect that the differences in the intensity of the color in the photographs could have been obtained as a result of different conditions under which the exposure was taken. However, all of the photographs were taken not only on the same day, but at the same time of day. Finally, in order to refute similar objections as so as not to force others to take my word for it, I will present one more photograph (Fig. 21) on which are depicted animals of varying colors lying side by side.

In conclusion, I will present a photograph (Fig. 22) of a bottle-nose dolphin kept in the Florida Oceanarium [from a recently published work by Y. Dillin (1952)]. As we can see, there are no differences in the color of this specimen and the Black Sea bottle-nose dolphins illustrated in my photographs. *76

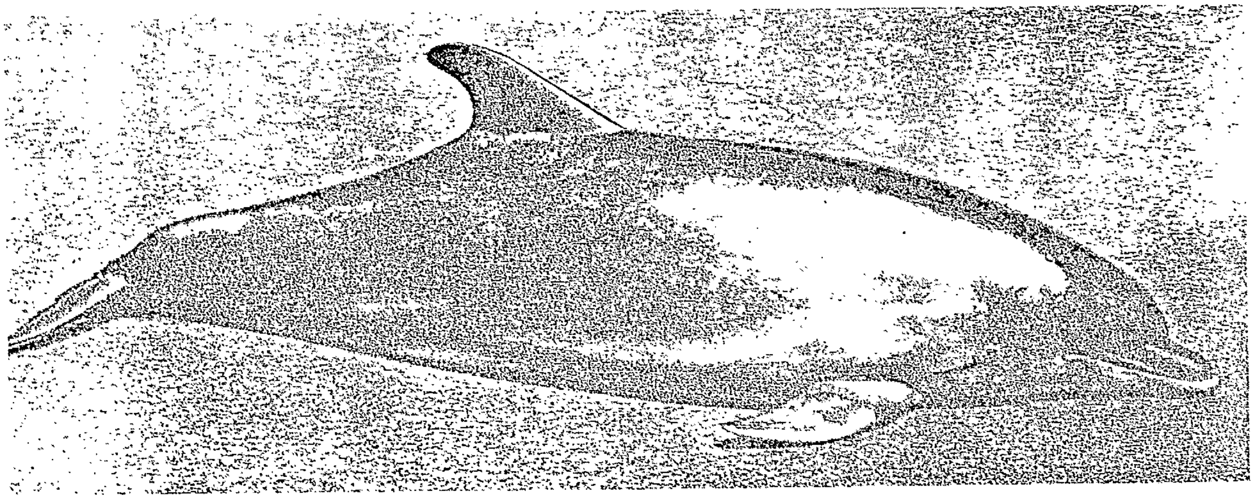


Рис. 20. Черноморская афалина (оригин.).

Fig. 20. A Black Sea bottle-nose dolphin (origin.).

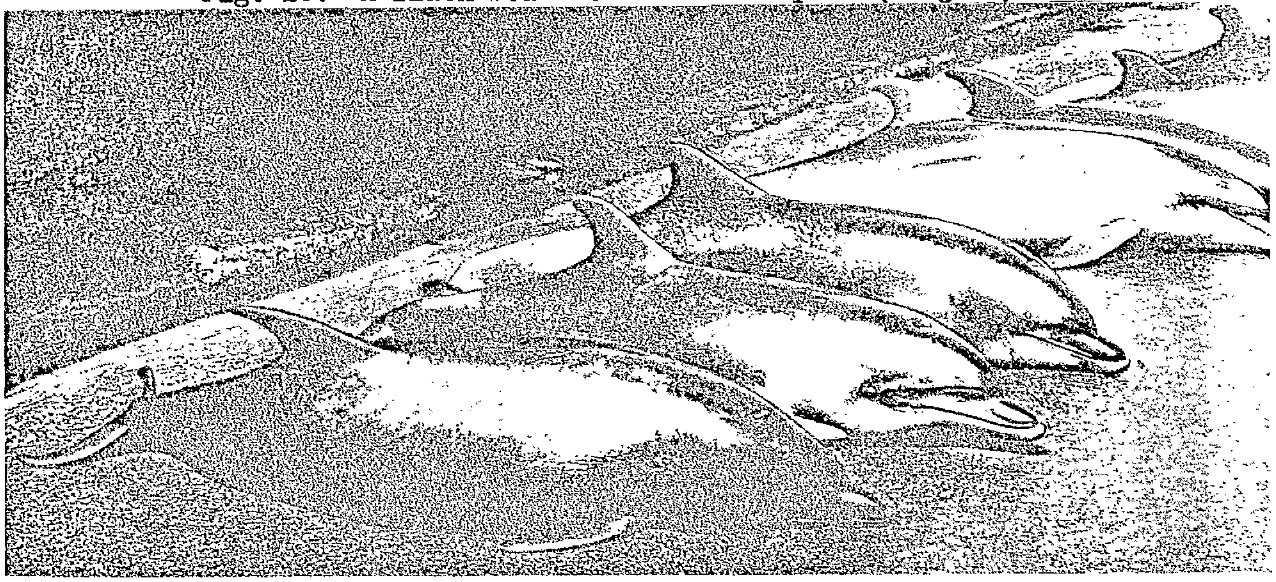


Рис. 21. Вариации в окраске тела черноморской афалины (оригин.).

Fig. 21. Variations in body color in the Black Sea bottlenoses (origin.).

Рис. 22. Окраска тела афалины из Флоридского океанариума (по И. Диллину).

Fig. 22. Body color of a bottlenose from the Florida Oceanarium (by Y. Dillin).

All of the presented photographs indicate with sufficient clarity the fact that:
1) the color of the Black Sea bottlenose varies intensely both with respect to the basic color as well as to the distribution of different pigmentations on the body of the animal;
2)the color of the Black Sea bottle-nose dolphins in no way differs from the color of the Atlantic and Mediterranean bottlenoses described by foreign authors. Indeed, among the photographs which I presented one can readily find specimens whose color corresponds exactly to the descriptions by Fischer (1881), True (1889), Flower (1880), Kükenthal (1909) presented above, in spite of those differences that can be established between the descriptions of the authors.
3) the color of the Black Sea Bottlenose does not fit at all its description given by Barabash-Nikiforov (1940) (see Fig. 17).

However, what amazes me more is how Barabash-Nikiforov, having at his disposal almost 1500 animals did not notice the variation in color which was displayed in the presented photographs, and which was revealed without any particular expenditure of time on only 50 animals. I cannot understand this circumstance at all.

Consequently, I was forced to conclude that the second feature to which Barabash-Nikiforov (1940) attached differential significance, i.e. the unique nature and constancy of color in the Black Sea bottlenose dolphin simply does not exist.

Let us turn to the craniological indices which include the third and fourth features established by Barabash-Nikiforov (1940). *77

Our data on cranial proportions of the Black Sea bottle-nose dolphin are very close to the data reported by Barabash-Nikiforov(1940), which can be seen from Table 10.

Table 10

Cranial proportions of the Black Sea bottle-nose dolphin.

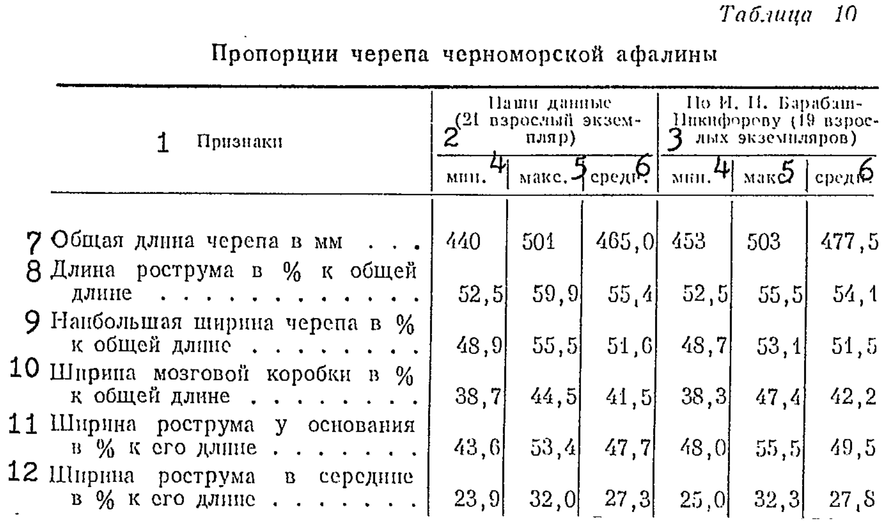


Таблица 10

Пропорции черепа черноморской афалины

1 Признаки	2 Наши данные (21 взрослый экземпляр)			3 По И. И. Барабаш-Никифорову (19 взрослых экземпляров)		
	мин. 4	макс. 5	средн. 6	мин. 4	макс. 5	средн. 6
7 Общая длина черепа в мм . . .	440	501	465,0	453	503	477,5
8 Длина рострума в % к общей длине	52,5	59,9	55,4	52,5	55,5	54,1
9 Наибольшая ширина черепа в % к общей длине	48,9	55,5	51,6	48,7	53,1	51,5
10 Ширина мозговой коробки в % к общей длине	38,7	44,5	41,5	38,3	47,4	42,2
11 Ширина рострума у основания в % к его длине	43,6	53,4	47,7	48,0	55,5	49,5
12 Ширина рострума в середине в % к его длине	23,9	32,0	27,3	25,0	32,3	27,8

Key to Table 10:

1) Features 2) Our data (21 adult specimens)

3) According to Barabash-Nikiforov (19 adult specimens)

4) Minimum 5) Maximum 6) Mean 7) Overall length of cranium in mm

8) Length of rostrum in % to overall length

9) Greatest breadth of cranium in % to the overall length

10) Width of braincase in % to the overall length

11) Width of rostrum at its base in % to its length

12) Width of rostrum in midlength in % to its length

The most significant difference in the mean values is observed only in the overall length of the skull, the length of the rostrum and the width of its base. According to our data, the overall length of the cranium is somewhat smaller, the length of the rostrum is greater, and the width of its base again is smaller. This can be explained by the fact that in our material there happened to be a greater number of female craniums than craniums of males. It will be evident from later discussions that the cranium in females in absolute figures is smaller than in males, and the rostrum - longer and narrower at the base.

Comparing his own material with that of Fischer's (1881) and True's (1889) data, Barabash-Nikiforov (1940) come to the conclusion that the rostrum in our dolphin is shorter, wider at the base and narrower at midlength. Our data do not support this which is evident from Table 11 (see p. 78).

Table 11

A comparison of the proportions of the rostrum of the bottle-nose dolphin from the Black Sea and other bodies of water.

Таблица 11

Сопоставление пропорций рострума афалины Черного моря
и других водоемов

1 Признаки	2 Наши данные (21 взрослый экземпляр)	3 По И. И. Барабаш-Никифорову	
		по его личным данным 4 ($n = ?$)	по данным Фишера и Тру 5 ($n = ?$)
6 Длина рострума в % к общей длине черепа	52,5—59,9	49,9—55,5	52,9—58,2
7 Ширина рострума у основания в % к его длине	43,6—53,4	45,5—55,5	41,0—51,9
8 Ширина рострума в середине в % к его длине	23,9—32,0	22,7—32,3	24,7—36,7

Key to Table 11:

1) Features 2) Our data (21 adult specimens)

3) According to Barabash-Nikiforov 4) On the basis of his personal data (n=?) 5) On the basis of Fischer's and True's data (n=?)

6) Length of rostrum in % to the overall length of the cranium

7) Width of rostrum at its base in % to its length

8) " " " in midlength in % to its length

As we can see, our figures are closer to Fischer's (1881) and True's (1889) figures than they are to Barabash-Nikiforov's (1940). It is significant that the most substantial disagreement between the figurees of the latter author and ours in the preceding Table turned out to be precisely in the rostral measurements which I explain by sexual dimorphism. Therefore, it is highly probable that the differences obtained between Barabash-Nikiforov's figures and those of the foreign authors are explained by the same factor.

Fischer (1881) had already noted that the rostrum in the bottlenose dolphin females is longer and narrower than in males. Barabash-Nikiforov (1940) writes in this regard that his materials "at least do not corroborate this diagnosis of sex differences that Fischer gives" (p. 62). Our material, on the other hand, not only confirms Fischer's (1881) data, but shows sex differences with respect to certain other features not indicated by Fischer, which can be seen from Table 12.

Those features which indicate sex differences in the cranial proportions are presented in Table 12. The remaining 35 features do not indicate such differences. One can easily be convinced of this fact if one looks through the table given in the Appendix where all 50 features are presented.

Таблица 12

1) Сопоставление пропорций черепа взрослых самцов и самок черноморской афалины в % от общей длины черепа

2 Признаки	3 Самцы ($n = 7$)			4 Самки ($n = 14$)		
	5 мин.	6 макс.	7 средн.	5 мин.	6 макс.	7 средн.
8 Общая длина черепа в мм	450	501	478	440	491	458
9 Длина рострума	52,5	56,0	54,5	54,3	59,9	55,9
10 Ширина рострума у основания	26,2	28,2	27,3	24.8	26,9	25,9
11 Ширина рострума у последнего зуба	18,6	22,0	20,3	17,3	19,7	18,5
12 Высота рострума у последнего зуба	8,2	9,4	8,6	6,8	8,5	7,5
13 Ширина рострума в средней части	15,3	17,5	16,1	13,6	15,2	14,6
14 Ширина межчелюстных костей в середине рострума	7,7	10,0	9,0	6,9	9,2	7,8
15 Длина верхнего альвеолярного края	43,3	46,9	45,3	44,6	47.2	46,4
16 Наибольшая ширина черепа	51,1	55,5	52,9	48,9	52,8	50,8
17 Межглазничная ширина . .	45,4	49,1	47,1	41,0	46,3	44,7
18 Максимальная ширина черепа в передней части лба	44,3	47,8	46,0	41,2	45,4	43,6
19 Ширина птеригоидного отверстия	15,9	17,7	16,9	14,7	16,4	15,4
20 Наибольшая высота черепа	41,1	45,1	42,2	38,7	42,7	40,6
21 Длина зуба в средней части верхней челюсти . .	12,0	16,0	13,7	5,0	12,0	10,8
22 Длина нижней челюсти . .	83,3	85,6	84,1	81,7	84,5	83,3

<u>Key to Table 12:</u>

1) Comparison of cranial proportions of adult males and females of the Black Sea bottle-nose dolphin in % of the overall length of the cranium

2) Features 3) Males (n=7) 4) Females (n=14) 5) Minimum 6) Maximum

7) Mean 8) Overall length of the cranium in mm

9) Length of the rostrum 10) Width of the rostrum at the base

11) Width of rostrum at the last tooth

12) Height of rostrum at the last tooth

13) Width of the rostrum at midlength
14) Width of premaxillaries at rostral midlength
15) Length of the upper alveolar margin
16) Greatest breadth of the cranium
17) Interorbital breadth
18) Maximum breadth of the cranium in the anterior section of the frons
19) Width of the pterygoid foramen
20) Greatest height of the cranium
21) Length of a tooth in the middle section of the maxilla
22) Length of mandible

As is evident from Table 12, the cranium of the females is not only smaller in overall length, but is lower and narrower than the cranium of males. It is narrower according to the width measurements of the facial section of the cranium as well (features 10, 11, 12). Regarding the configuration of the rostrum, Table 12 provides a basis for concluding that in the females the rostrum is longer and narrower than in males according to all of the width measurements, while in the latter, it is shorter and bulkier. Thus, those differences in the measurements of Nikiforov (1940) in Table 10, and between his data and the materials of foreign authors (Table 11), can be explained by sexual dimorphism in cranial proportions.

As a result, the third feature to which Barabash-Nikiforov (1940) attached differential significance, does not have any.

Just as I had done for the preceding species, I took measurements on two craniums of bottle-nose dolphin from other bodies of water preserved in the USSR Academy of Sciences Zoological Museum under the inventory numbers 21982 and 22530. Having selected craniums corresponding in size from our materials on the Black Sea dolphin, I compare the measurements of both in Table 13, in which, due to the deficiencies of the craniums in the USSR. Acad. of Sci. Zoolog. Musuem, I am unable to present data on all *80 of the measurements as was done in the common dolphin.

The differences in all of the measurements, as can be seen from Table 13, cannot be considered significant.

Таблица 13

1 Сопоставление измерений черепов афалин Черного моря и других водоемов в мм

2 Признаки	Среднее для 3 черепов дельфинов Черного моря 3	Среднее для 2 черепов дельфинов других водоемов 4
5 Общая длина черепа	467,3	467,5
6 Основная длина черепа	456,0	457,0
7 Длина лицевого отдела	306,0	307,0
8 Длина мозгового отдела	161,3	160,5
9 Длина рострума	257,3	258,0
10 Ширина рострума у основания	126,1	124,5
11 Ширина рострума у последнего зуба	93,7	92,0
12 Ширина рострума в его середине	74,9	74,5
13 Высота рострума у последнего зуба	40,0	41,5
14 Длина верхнего альвеолярного края	213,3	214,5
15 Длина основной кости	88,7	90,0
16 Длина преддыхала	48,7	49,0
17 Расстояние от нижнего края затылочного отверстия до заднего края альвеолярного ряда по средней линии	239,7	242,5
18 Расстояние от затылочного гребня до конца рострума по средней линии	410,0	409,0
19 Расстояние от носовых костей до конца рострума по средней линии	373,3	375,5
20 Наибольшая ширина мозговой коробки	196,3	199,0
21 Межглазничная ширина	209,3	209,0
22 Ширина межчелюстных костей в середине рострума	40,2	38,5
23 Ширина развилки межчелюстных костей	94,0	92,0
24 Поперечный диаметр дыхала	52,3	54,5
25 Ширина птеригоидного отверстия	78,6	78,0
25 Кондилярная ширина	97,0	99,5
26 Кондилярная высота	59,8	60,5

Key to Table 13:

1) Comparison of cranium measurements of bottle-nose dolphin from the Black Sea and other bodies of water in mm

2) Features 3) Mean for 3 craniums of Black Sea dolphin

4) Mean for 2 craniums of dolphin from other bodies of water

5) Overall length of the cranium 6) Basic length of cranium

7) Length of facial section 8) Length of braincase 9) Length of rostrum

10) Width of rostrum at the base 11) Width of rostrum at last tooth

12) Width of rostrum in midlength 13) Height of rostrum at last tooth

14) Length of upper alveolar margin 15) Length of basilar process

16) Length of prenarial shield

17) Distance from the inferior margin of the foramen magnum to the posterior edge of the alveolar row along a medial line

18) Distance from the occipital crest to the tip of the rostrum along a medial line

19) Distance from the nasal bones to the tip of the rostrum along a medial line

20) The greatest width of the braincase 21) Interorbital breadth

22) Width of the premaxillaries at rostral midlength

23) Width of the premaxillary bifurcation

24) Transverse diameter of the blowhole

25) Width of the pterygoid foramen

26) Condylar width 27) Condylar height

Let us dwell on the last feature established by Barabash-Nikiforov (1940); that of the number of teeth.

"The total number of teeth," writes Barabash-Nikiforov (1940), *81 "varies in our specimens within the limits of 76 to 89" (p. 62). According to our data, the number of teeth varies roughly within some limits (from 74 to 90).

Barabash-Nikiforov continues farther: "The fluctuation in the number of teeth in each of the upper and lower jaws can be represented by the formula 20-23/18-22.

These data approximate Fischer's (corresponding formula: 21-24/20-23) and True's data (corresponding formula: 23-26/24-24). According to Trouessart (1910) and Freund (1932), the number of teeth in _T_. _truncatus_ is established as 21-25 and 22-25 for each half of the jaw. In general, judging from these data, our specimens differ from the ones described by the foreign authors by a somewhat smaller number of teeth" (p. 62).

According to our data, the corresponding dental formula in the Black Sea bottle-nose dolphin is 20-25/18-22. From a comparison of all of the figures presented above, it follows that:

1) our data are as close to Barabash-Nikiforov's (1940) as they are to Fischer's (1881);

2) Barabash-Nikiforov's (1940) and our data differ from Fischer's (1881) material to the same degree as True's (1889), Trouessart's (1910) and Freund's (1932) data differ from those materials.

These facts lead to the conclusion that there are no grounds for attaching differential significance to this feature as Barabash-Nikiforov did, the more so since Barabash-Nikiforov (1940) himself quite correctly notes that "in some instances [the feature of - Trans.] the number of teeth does not lend itself to precise establishment" (p. 62).

Thus, having analyzed all of the features indicated by Barabash-Nikiforov (1940), it can be maintained that they either do not exist in nature or are a manifestation of sexual and individual variability, and, consequently, provide no bases for establishing a Pontic subspecies of the bottle-nose dolphin. It is quite evident that by a virtue of what has been said, the significance of a subspecies for this dolphin should not be retained.

In conclusion to this section, I will dwell on helminthological data, in order to obtain which we are entirely indebted to the works of our helminthologist, S. L. Delamure (1941, 1945, 1946, 1949, 1950, 1951, 1951a, 1952, 1955). The biological significance of his works will be discussed later, right now I will touch upon them only in that section where Delamure (1952, 1955) substantiates his view on the taxonomy of the Black Sea dolphins. His data are based on an enormous amount of factual material. It is sufficient to point out that, working according to Academician K. I. Skryabin's method, he dissected 767 common dolphin *82
specimens, 62 specimens of the harbour porpoise and 18 bottlenoses for helminthological purposes.

The first thing that Delamure established is the extreme impoverishment of the Black Sea helminthofauna in comparison with the helminthofauna of these same species of dolphin from the Mediterranean Sea and the Atlantic Ocean (9 versus 32).

The second factor is the specificity of certain helminths peculiar only to the Black Sea dolphins. Thus, the following three species of helminths were isolated from the common dolphin: *Campulla palliata* (trematode), *Halocercus kleinenbergi* (nematode), *Skrjabinalius cryptocephalus* (nematode).

Common to the dolphin of the Mediterranean Sea and the Atlantic Ocean is only the first species of trematode which occurs extremely rarely in the Black Sea common dolphin. The two other species of nematode occur only in the Black Sea common dolphin.

Four species of helminths are recorded in the Black Sea harbour porpoise Diphyllobothrium stemmacephalum (cestode), Halocercus taurica (nematode), Halocercus ponticus (nematode), Stenurus minor (nematode).

Common to the dolphins of the same species from other areas of the range are: the first and fourth species (cestode and nematode); 100% of the Black Sea dolphins being infested with the latter. The second and third species (nematodes) are specific only to the Black Sea dolphins and are not recorded in other areas of its range.

Delamure (1955) did not find any species of helminths specific to the Black Sea bottlenose at all. This served as a basis for the author's conclusion regarding the fact that the Black Sea common dolphin and the harbour porpoise have their own, specific species of helminths, and that they are absent in the bottlenose and that resulting from this, the isolation of the first two species has progressed farther than in the third species. Basing himself on this fact, Delamure (1955) shares Barabash-Nikiforov's opinion (1935, 1940) regarding the taxonomic status of the Black Sea common dolphin, and Tsalkin's (1938) opinion - with respect to the part on the taxonomic status of the harbour porpoise, but does not agree with Barabash-Nikiforov's (1940) point of view in his interpretation of the taxonomic position of the bottlenose.

It is necessary to dwell on a third, extremely important fact quite correctly emphasized by Delamure (1955), and specifically, on the

the absence in the Mediterranean dolphin of the helminths (Skrjabinalius cryptocephalus, Halocercus kleinenbergi, H. taurica, H. ponticus) peculiar to the Black Sea dolphins, and on the other hand, on the absence in the latter of the helminths (Braunina coreliformis, Tetrabothrium forsteri, Monogrima grimaldii, Phyllobothrium delphini, Bolosoma vasculosum) *83 peculiar to the Mediterranean dolphins. In Delamure's opinion, this indicates the absence of permanent contact between the dolphins of the Black and Mediterranean Seas, and consequently, the absence of a broad exchange of delphine fauna between the seas. This conclusion refutes the opinion circulated in literature regarding permanent migrations of the dolphins of the Black and Mediterranean Seas. Thus, one can only speak of penetrations of Mediterranean dolphins into the Black Sea and vice versa, but by no means of permanent mass migrations from one sea to another. Consequently, the Black Sea dolphin populations have to be considered as more or less isolated.

If it is recognized, as Delamure does, that helminthological data can serve as one of the criteria in the issue of the taxonomic status of the host, then it is necessary to emphasize that the helminthological data point to a longer-standing and further-progressed isolation of the Black Sea common dolphin in comparison with the two remaining species of Black Sea dolphin.

Thus, an analysis of the taxonomic status of the Azov-Black Sea dolphins and the considerations expressed in the preceding section of this chapter regarding the representatives of the pinnipeds, enable us in summarizing to give the following list of mammals inhabiting the Black and Azov Seas.

LIST OF MAMMALS OF THE AZOV-BLACK SEA BASIN

ORDER PINNIPEDIA

1. Monachus monachus Hermann, 1779

Phoca vitulina Hablizl, 1785.

Phoca monacha Pallas, 1811;

Phoca monachus Eichwald, 1831; Nordmann, 1840;

Pelagius monachus (Herm.) Nikol'skii, 1891;

Monachus albiventer (Gray) Smirnov, 1908; Zernov, 1913a; Puzanov, 1929.

Monk seal or white-bellied seal

At the present time very rare in the Black Sea.

Ranges from the coast of the Island of Madeira and the Canary Islands in the Atlantic Ocean, across the entire Mediterranean Sea (Adriatic, Aegean Seas, the Sea of Marmara) to the Black Sea, inclusively.

ORDER CETACEA

1. Delphinus delphis ponticus Barabasch, 1935.

Delphinus delphis L. Eichwald, 1830, 1831; Rathke, 1837; Nordmann, 1840; Kessler, 1861; Nikol'skii, 1891; van-Beneden, 1892; Ostroumov, 1892; Sovinskii, 1902; Satunin, 1903; Silant'ev, 1903; Dinnik, 1910; Zernov, 1913a; Kozlov, 1921; Shikhov, 1923; Devedzhan, 1926; Puzanov, 1929; Mal'm, 1932, 1933; Kravchenko, 1932; Kleinenberg, 1951. Delphini delphis Kaleniczenko, 1839.

Vorvon dolphin (in older authors), common dolphin, tyrtak, sharp-snouted dolphin, white-sided sea pig or white-sided dolphin[1]

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[1] Trans. note: All Russian common names for Delphinus. Also, I was hoping to avoid another confrontation with the Russian common nomenclature regarding Delphinus by using the English common name "common dolphin" rather than attempting a too literal translation of the Russian belobochka

In the Black Sea, the most common, most widely distributed and the most numerous form.

Outside of the confines of the Black Sea, this species is extremely widely distributed in the Northern and Southern Hemispheres. North of the Atlantic Ocean, it is well known to the shores of Norway and Iceland. Millais (1906) indicates it even for the Greenland Sea. It is also well known to the sea coasts of North America. Occurs in the Baltic and North Seas and along the Atlantic coast of Europe. Common in the Mediterranean. Occurs near the African coastlines and crossing the equator, goes as far as the Cape of Good Hope and the Trsitan da Cunha Islands.

In the Pacific Ocean, it ranges near the shore of California and near the coastlines of Japan where it is common. H. Scott and C. Lord (1921) and G. Pearson (1936) consider it to be the most common species for the Australian, Tasmanian and New Zealand coasts.

2. Phocaena phocaena L. 1758

Delphinus phocaena Hablizl, 1758; Meier, 1794; Georgi, 1802; Pallas, 1811; Eichwald, 1830, 1831; Rathke, 1837, Nordmann, 1840; Simashko, 1851; Kessler, 1861, Sovinskii, 1902; Sernov, 1913a.

Delphini phocaena Kaleniczenko, 1839.

Phocaena communis Cuv. Kessler, 1861; Nikol'skii, 1891; van-Beneden, 1892; Ostroumov, 1892; Satunin, 1903; Silant'ev 1903; Dinnik, 1910; Kiselevich, 1922; Kravenchko, 1932.

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or del'fin-belobochka which literally means "white-sided dolphin". The problem arises with the common name "white-sided dolphin" which according to Ricker (Eng.-Russ. Dictionary...pp. 19, 60-61 is used to refer to Lagenorhynchus acutus which the Russians refer to in common terminology also as belobochka as well, including belobokii del'fin "white-sided dolphin". Therefore in the text proper I have used only common dolphin to refer specifically to Delphinus delphis ponticus.

Phocaena relicta Abel, 1905; Satunin, 1914; Shikhov, 1923; Devedzhan, 1926; Puzanov, 1929; Malm, 1932, 1933; Barabash-Nikiforov, 1940; Freiman, 1951.

Phocaena phocaena relicta Abel, Tsalkin, 1938; Tomilin, 1939, 1951; Kleinenberg, 1951.

Sea pig, *blunt-snouted dolphin*, *chushka*, *burtuk*, *mutur*, *sapun*, *pykhtun*, *Azov-dolphin*, *azovka*[1] *85

Inhabits the Azov and Black Seas. Considerably less numerous than the first form.

Beyond the shores of the Azov-Black Sea basin, it is distributed only in the northern hemisphere, along the coasts of the Atlantic and Pacific Oceans. Concerning its distribution in the Mediterranean Sea, the issue is not clear up until the present time. Thus, P. van-Beneden and P. Gervais (1880) were the first to point out the absence of this dolphin in the Mediterranean Sea. Abel (1905), for whom this fact was one of the most essential elements in his conception regarding the origin of this dolphin, also denied its presence in the Mediterranean Sea. This position was shared by M. Weber (1928), Heptner (1936), Tsalkin (1938) and others. Nevertheless, Flower and R. Lydekker (1891) indicated entries of dolphin into the Mediterranean Sea, and Millais (1906) and Trouessart (1910) speak of its presence in the Mediterranean and Adriatic Seas. Finally, Devedzhan (1926) noted that this dolphin is seldom caught in the Bosporous and the Sea of Marmara from where it enters into the Mediterranean Sea as well. Chapskii (1941) included the Mediterranean in the range of this dolphin

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[1] Trans note: These are also the various Russian common names applied to Phocaena.

as well; but Kiselvich (1922) reported: "The northern form of the dolphin Phocaena communis occured previously in the Mediterranean Sea. It does not occur there anymore although it is fairly frequent in the Black and particularly the Azov Seas" (p.23).

Since the harbour porpoise is distributed along the Atlantic coast of Europe up to the Straits of Gibralar, then instances of entry by this dolphin into the Mediterranean from the Atlantic side are quite probable. Thus, it is necessary, apparently, to consider that this dolphin is generally rare in the Mediterranean Sea, and that its complete absence here can be explained, as Kirpichnikov (1952) correctly notes, by the absence here of regular commercial dolphin whaling.

Occurring along the entire Atlantic coast of Europe, the harbour porpoise is extremely common in the North Sea. In the Baltic Sea, it was noted by W. Lilljeborg (1866), Mela (1882), A. F. Terent'ev (1900), Chapskii (1941) and others. According to Terent'ev's testimony, it enters into the Neva as well, and E. Bichner (1902) mentions its entries into Lake Ladoga. This dolphin is indicated for the White Sea by Mela (1882), Pleske (1887), A.A. Birulya (1933, 1934), Chapskii (1941). Common in our northern waters, and in particular along the Murman Coast, where its frequent occurrences were noted by K. M. Deryugin (1915), A. N. Formozov *86 (1929), Birulya (1933), M. Kol'tsov (1934), A. Golenchenko (1936), the latter authors considering it possible to organize a commercial industry here involving this dolphin. The eastern-most point in the distribution of the harbour porpoise in the north, according to Chapskii, is the mouth of the Pechora River.

Along the Atlantic coast of America, the harbour porpoise is distributed from Davis Strait to the State of New Jersey, inclusively (True, 1899; Trouessart, 1898-1899); and along the Pacific coast - from Southern California to Alaska (Th. Gill, 1865; Flower, 1833; True, 1889; G. Miller, 1930, et al.). It is extremely common, according to W. Turner's (1886) testimony, near the shores of the Aleutian Islands. In our Far Eastern waters, it occurs (according to Terent'ev) from the Bering Strait along the coasts of the Bering Sea, Sea of Okhotsk, and the Sea of Japan. Tomilin (1947), basing himself on True's (1889) and G. Allen's (1932) data, considers that beginning from the southern coastlines of Japan and farther south, the harbour porpoise is displaced by a close, representative form, Neomeris phocaenoides.

3. Tursiops tursio[1] Fabr. 1780

Delphinus tursio Rathke, 1837; Nordmann, 1840; Simashko, 1851; Nikol'skii, 1891; Sovinskii, 1902; Zernov, 1913a.

Tursiops truncatus ponticus. Barabash-Nikiforov, 1940; Tomilin, 1951; Freiman, 1951.

Nezarnak dolphin (in older authors), black sea pig, ofalina, afelin, afalin, or afalina

Inhabits the Black Sea. Far less numerous than the second species.

Outside the confines of the Black Sea, distributed less widely than the common dolphin, besides, only in temperate waters of both hemispheres.

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[1] I retain specifically this species name and not the second - "truncatus" (Montagu, 1821). Barabash-Nikiforov (1940), Tomilin (1951) and many other authors adhere to the second specific name on the basis of an incomplete diagnosis established in the first description of the species (Fabricius, 1780), and therefore reduce this description to a nomen nudum. I consider that it is possible to reduce it to this category only in the absence of a diagnosis, but we have no right to reduce the first description to a nomen nudum on the basis of an incomplete diagnosis.

Being common to the Mediterranean Sea, this dolphin ranges along the entire Atlantic coast of Europe, as far north as the southern coastlines of Norway. It is also distributed in the North Sea, but Lilljeborg (1886), Mela (1882), K. Greve (1909) and others note it for the Baltic *87 Sea as well. This dolphin is not indicated for the White and Barents Seas, and farther northward and eastward.

Along the Atlantic coast of North America, according to True (1889), ranges from Portland in the north to the Gulf of Mexico in the south; and for the coasts of South America, according to H. Burmeister (1868), near the coastlines of Uruguay and Argentina. Along the Pacific coast of the United States of America, V. Beiley (1936), indicates it for the coasts of Oregon, California and Mexico.

In the Pacific Ocean, it is well-known to the coasts of Japan, China and India. Noted also in the Red Sea, along the coasts of Africa and the Seychelles Islands (C. Scammon, 1874; van-Beneden, 1888; True, 1889).

The bottlenose was noted for the coasts of Australia, Tasmania and New Zealand by Scott and Lord (1920).

If a general outline of the range of this heat-loving form were plotted on a map, it seems as though it would encircle the globe along the equator, extending from up to 45° northward and southward and up to 65° north latitude only along the Gulf Stream (the coastlines of Norway).

3. A BRIEF SURVEY OF THE HISTORY OF THE FORMATION OF THE CETACEAN FAUNA OF THE BASIN

Despite the fact that the history of the origin of the toothed cetaceans can be traced back in literature [M. Weber (1886, 1927-1928), V. Kükenthal (1889-1893), W. Flower and R. Lydekker (1891), O. Abel

(1902, 1912, 1919, 1928), H. Winge (1921), R. Kellog (1928), et al.] to earlier times than that of the whalebone whales, we will not dwell on this issue. In the present case, we are interested only in the appearance of the dolphin in the Black and Azov Seas. It is obvious that it is impossible to discuss the latter issue without even a brief account of the history of the formation of the present-day Black Sea.

It is impossible to examine the history of the Black Sea in isolation from the history of the Caspian Sea since in the geological past they formed a single continuous body of water. As a result, they are closely related genetically.

Not being able to dwell on the history of our southern sea in any amount of detail, I was forced to confine myself to an outline, having indicated only the main literary sources.

The study of the formation of our southern seas is inseparably linked with the names of two of the most prominent Russian geologists: N. I. Andrusov and A. D. Arkhangel'skii.

The presence of hydrogen sulphide in the deep sea sections of the Black Sea was established for the first time by Andrusov (1890) during an expedition on the "little Black Sea". Attributed to him as well is the beginnings of the development of the history of the origin of our southern seas (Andrusov, 1888, 1897, 1917, 1918, 1923, 1927, 1928). *88

Arkhangel'skii (1933) alone, and in collaboration with N. M. Strakhov (A. D. Arkhangel'skii and N. M. Strakhov, 1932, 1938) establsihed the stratigraphy of the bottom deposits of the Black Sea and ascertained the more complex course of the Quarternary history of the basin. The works of Arkhangel'skii and Strakhov, based on a large amount of factual material, permitted the establishment of conclusions which remain unshakable until the present time. Finally, this outline of Arkhangel'skii's and Strakhov's, in connection with the study of the development of the region surrounding the Black Sea, has recently been complemented in detail by M. V. Muratov (1949, 1951).

The very complex geological history of our southern seas is concisely and clearly set out by A. K. Kiselevich (1922), L. A. Zenkevich (1947) and others. This history is described roughly in the following manner: during the Middle Miocene period, there was this huge sea basin uniting the present-day Black and Caspian Seas. This basin, which had a connection with the ocean, is regarded as a remnant of the Tethys Sea. In the course of geological time, in spite of the changes occurring throughout the entire Miocene period and Lower Pliocene, the area occupied by the present-day Black and Caspian Seas is regarded as a single basin. During the Pliocene (Pontic) period, the basins situated on the location of the present-day Black and Caspian Seas, separated, but intermittent connections between them continued to develop throughout the entire Pliocene period and even during the post-Tertiary period. The Sea of Marmara, separated from the Mediterranean, was connected to the basin which was on the location of the present-day Black Sea during the Ploicene period, and in my opinion of some researchers, this connection existed even earlier, namely the Upper Miocene. The connection between the basin, situated on the location of the Black Sea, and the Mediterranean Sea, was established only in the Quarternary period, during the course of which it was sometimes broken, and at other times re-established.

During the course of geological history, as a result of various

TABLE 14

Marine Middle Miocene Basin
(remnant of the Tethys)[1]

Таблица 14

Полносоленый среднемиоценовый бассейн
(остаток Тетиса)[1]

1. Верхний миоцен	a. Солоноватый Сарматский бассейн (на восток за Аральское море, на запад до Среднедунайской низменности). К концу сильное уменьшение размеров, а затем опять увеличение и переход	
	b. Меотический бассейн; полуморской „эвксинский" режим [Державин (1925) полагает, что было соединение Черного моря с Мраморным]	
2. Плиоцен	a. Понтический бассейн, значительное опреснение Меотического бассейна. Опресненный „Каспийский" режим. В конце его обособление Черного, Каспийского и Аральского[2] морей	
	b. Киммерийский бассейн	c. Бассейн продуктивной толщи
	d. Куяльницкий бассейн	e. Акчагыльский бассейн (имелась временная связь с Куяльницким бассейном)
	f. Чаудинский бассейн (имелось сообщение через Босфор с Мраморным морем, имевшим малую соленость и со Средиземным морем не сообщавшимся)	g. Апшеронский бассейн (имелась временная связь с Чаудинским бассейном)
		h. Бакинский ярус
3. Послетретичное время	a. Древнеэвксинский бассейн (фауна каспийского типа)	b. Древнекаспийский бассейн (временная связь через сток с Черным морем через Кумо-Манычскую впадину)
	c. Установление связи со Средиземным морем (Карангатское море)	
	d. Новоэвксинский бассейн	e. Послеледниковая трансгрессия. Современный бассейн
	f. Современная фаза	

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[1] По Л. А. Зенкевичу, 1947, стр. 261.

[2] Здесь явная ошибка, ибо Аральское море развивалось самостоятельно, не будучи связано ни с Каспийским, ни с Черным морями.

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[1] From L. A. Zenkevich, 1947, p. 261.

[2] Here there is clearly an error, for the Aral Sea developed independently, not being connected either with the Caspian nor the Black Seas.

Key to Table 14:

1. Upper Miocene
    - a) Brackish Sarmatian Basin (eastward beyond the Aral Sea, westward to the Middle Danube Lowland). Toward the end, an extreme decrease in size, followed again by an enlargement and a transition.
    - b) Maeotitic Basin; semimarine "Euxine" regime [Derzhavin (1925) assumes that the Black and Marmara Seas were combined]
2. Pliocene
    - a) Pontic Basin, a considerable decrease in salinity of the Maeotitic Basin. A decreased saline "Caspian" regime. In its final stage, the separation into the Black, Caspian and Aral[2] Seas.
    - b) Cimmerian Basin
    - c) Basin of productive stratum
    - d) Kuyalnitskii Basin
    - e) Akchagyl'skii Basin (having a temporary connection with the Kuyalnitskii Basin)
    - f) Chaudinskii Basin (there was a connection through the Bosporous with the Sea of Marmara which had a low salinity and which had no connection with the Mediterranean Sea)
    - g) Apsheronskii Basin (there was a temporary connection with the Chaudinskii Basin
    - h) Baku Stage
3. Post-Tertiary
    - a) Paleo-Euxine Basin (fauna of the Caspian type)

b) Paleo-Caspian Basin (temporary connection through a channel with the Black Sea across the Kumo-Manychskii Trench)

c) The establsihment of a connection with the Mediterranean Sea (Karangatskii Sea).

d) Neo-Euxine Basin

e) Post Glacial transgression. Present day Basin

f) Present-day Stage.

An account of the history of our southern seas presented here in the most general terms is nicely illustrated in Table 14, which I took the liberty of borrowing from Zenkevich (1947) and which can serve as a background for later discussion of the paleontological material on the groups of animals we are discussing at the time. *90

It is impossible not to mention that zoologists, on the basis of the fauna of the southern seas, expressed quite accurate opinions regarding the geological past of the Black Sea. Thus, Kessler (1877, 1878) had already come to the conclusion that the Black Sea and the Caspian Sea were at one time a single brackish body of water; that the separation of the Black and Caspian Seas occurred earlier than the union of the Black Sea with the Mediterranean; and that the transmigration of the Mediterranean; and that the transmigration of the Mediterranean fauna into the Black Sea is observed even in our time.

Ostroumov's works in the Azov, Black and Marmara Seas and in the Bosporus (A. A. Ostroumov, 1892, 1892a, 1893, 1896, 1897, 1902) showed that the Sea of Marmara was connected to the Pontic Basin and was separated from the Mediterranean Sea; that there is a similarity in the fauna of the Atlantic coast of Western Europe which are in turn absent in the fauna of the Mediterranean Sea.

On the **basis** of an analysis of the fauna of the southern seas, Sovinskii (1902) expressed a similar notion.

As the Black and Mediterranean Seas united, the former began to be populated by Mediterranean fauna as much as the comparatively low salinity of the Black Sea would allow. On the basis of analysis of the molluscan fauna, A. Middendorf (1848) had already come to the conclusion that the fauna of the Black Sea is essentially an extremely impoverished Mediterranean fauna. Puzanov (1938), speaking on the impoverishment of the fauna according to how far removed they are from the Mediterranean, notes the following: "If one were to designate the number of species of molluscs of the Aegean Sea by 100, then in the Sea of Marmara with a salinity of a little more than 2%, there are 84 of them, 58 in the Bosporus, 22 in the Black Sea; on the other hand, only 6 species reach the Azov Sea" (p. 185).

The population of the Black Sea by Mediterranean ichthyofauna was also proven by V. A. Vodnyanskii (1930) and other researchers.

The complex geological history of the Black Sea could not help but be reflected in its fauna which is composed of several components; Mediterranean immigrants, fresh-water forms and relict fauna enter into its composition.

Our Black Sea dolphins were also regarded as Mediterranean settlers. Thus, van-Beneden (1892), in a report to the Second Session of the International Zoological Congress in Moscow, quite definitely developed the idea regarding the fact that all Cetacea that existed in the Ponto-Caspian Basin became extinct, and that the present-day cetacean fauna of the Black Sea are new-comers from the Mediterranean Sea. It is true that certain areas of that report are astonishing in their lack of information. Thus, for example, it contained a discussion of a seal in the Aral Sea, the latter being regarded together with the Caspian seal as a descendant of the present-day Baikal seal. *91

In this report it was also maintained that the Cetacea inhabiting the Ponto-Caspian Basin could swim from Novaya Zemlya to the foot of the Caucasus, etc.

After the appearance of Abel's (1905) work, the view on the origin of the Black Sea dolphin changed. All of the subsequent authors, having accepted Abel's point of view, regarded the harbour porpoise as a relict from and the other two species as Mediterranean immigrants. Abel's view (1905) on the origin of the genus <u>Phocaena</u> formed the basis of E. Slijper's (1936) and others' phylogeny of that genus. In addition to that, as was already mentioned above, Abel's position requires thorough reconsideration. Let us turn therefore to the extremely scanty, it is true, but nonetheless available paleontological material that is at our disposal.

In 1889, while conducting his work on the Taman Peninsula, Andrusov (1904) discovered a fragment of the cerebral section of a skull, a scapula and several bones of the front limbs of a dolphin in the Chokrakskii deposits of the Middle Miocene Period. This material was sent to Abel who (1905) described <u>Palaeophocaena</u> <u>andrussowi</u> on the basis of this material. Abel found a similarity between these fossil remains and a skull of a present-day Black Sea harbour porpoise. On the other hand, he found those differences, which were discussed in the previous section, between the present-day dolphins of this species from the Black Sea and the Atlantic Ocean. All of this together then, formed the basis of Abel's theory in accordance with which the present-day harbour porpoise developed in the place of its present habitation, representing in this way a relict species, and the fossil form Palaeophocaena andrussowi, the ancestor of the entire genus Phocaena. The invalidity of Abel's arguments presented in support of the establishment of Phocaena relicta has already been demonstrated earlier.

Nevertheless, Abel's views continued to find support in our literature. Thus, Bogachev (1938, 1939) regarded the present-day Black Sea harbour porpoise as a relict form descended from P. andrussowi. Barabash-Nikiforov (1940), supporting Abel's position, presented the following argument: "Among the fossil representatives of the dolphin found within the confines of the ancient Russian seas, we find a number of forms which are more or less genetically connected with our present-day genus Phocaena" (p. 73). Moreover, apart from a reference to the fossil form *92 described by Abel (1905), he also makes reference to Phocaena euxinica fossilis from the Kishinev Sarmatian Stage described by Nordmann (1860). Nevertheless, it is well-known that the material which Nordmann used in the description of the indicated form was already analyzed by I. Brandt (1873) who relegated it to another genus of dolphin - namely Chamsodelphis.

To the same species Brandt (1873) relegated Delphinopsis freyeri as well, described by I. Müller (1853) from the Sarmatian Stage in Yugoslavia and which was attributed at the time to the subfamily Delphininae. As a result, Barabash-Nikiforov's (1940) reference to the fossil form described by Nordmann (1860) is without basis.

A revision of the fossil form P. andrussowi described by Abel (1905) was most recently conducted by Kirpichnikov (1952). From illustrations presented by Abel in that work and from the text, Kirpichnikov established: 1) that the posterior, pre-nasal section of the premaxillaries is relatively broad, compressed and interlocks with the lateral edges of the nasal bones; 2) that the frontal bones behind the nasal bones have a slight bulge; 3) that the bones of the fore limbs have a similarity with analogous bones of the fossil dolphin - Delphinopsis freyeri Müll. from the Sarmatian Stage in Yugoslavia which Abel also attributed to the harbour porpoise on that basis. Craniological features noted by Kirpichnikov (1952) on illustrations (even though dark ones) presented by Abel (1905) stand out distinctly, and one can only wonder how none of the researchers up until the present time took any notice of this when these features in the structure of the cranium are characteristic of representatives of the family Delphinidae. In the representatives of the family Phocaenidae, on the other hand, the premaxillaries in the posterior section are not compressed and do not form a broadening, and the fossil bones rise high and steeply above the nasal bones. Thus Kirpichnikov (1952) quite correctly writes: "The noted features in the structure of the premaxillaries and the nasal bones are characteristic of the family Delphinidae (according to G. Simpson's (1945) classification or the subfamily Delphininae by the old classification) ...The similarity in the structure of the bones of the fore limbs which Abel noted in the dolphin he studied to the corresponding bones of Delphinopsis freyeri Müll. attributed by all of the researchers to Delphinidae, can complement the confirmation that the bones that Abel had in his possession also belonged to that family and not the family Phocaenidae as he himself considered" (p. 723).

Kirpichnikov also sees no basis for attributing to the Family *93 Phocaenidae Protophocaena minima from the Miocene period in Belgium described by Abel (1905a).

"Thus," concludes Kirpichnikov (1952), "at the present time we have no basis for retaining within the composition of the family Phocaenidae the genus Paleophocaena established by Abel; he would be more justified in setting aside a spot among the representatives of the family Delphinidae" (p. 724).

It remains for me only to state that Abel's (1905) concept regarding the origin of the present-day Black Sea harbour porpoise is totally unacceptable.

I have already commented earlier on the fossil Sarmatian Stage dolphins described by Müller (1853), Nordmann (1860), Brandt (1873) and finally Abel (1905). In 1933, M. V. Pavlova wrote on the fossil dolphins of the Black Sea. However the nomencalture in her work was so confused, and the text, apparently during typesetting was so distorted in some places that it simply impossible to make any sense out of it. Therefore, I was obliged to put this work aside.

Fairly recently, N. Macarovici and C. Oescu (1942), having described a dolphin on the basis of the remains of a skeleton from the Sarmatian Stage in the vicinity of Kishinev, relegated it to Champsodelphis fuchsii Brandt. It should be emphasized that the authors note a greater closeness in the structure of the scapula of the fossil dolphin they were describing to the structure of the scapula of the present-day dolphin Delphinus delphis.

Following these authors, I. Simionescu (1943) described a damaged skull of a dolphin from the same stone quarries near Kishinev, however he did not establish either the specific or generic affiliation of the described specimen.

Finally, Kirpichnikov (1945) described a new species and genus of a fossil dolphin which he called Leptodelphis stavropolitanus on the basis of a skull from the Sarmatian stage of Stavropol. Kirpichnikov (1954) described a second new species and genus Sarmatodelphis moldavicus on the basis of Simionescu's (1943) data. Both of these dolphin are attributed to the family Delphinidae by the author.

I consider it possible to share only entirely Kirpichnikov's observation (1952) who writes: "...up until the present time, there have been no authentic remains of Phocaenidae found in the Miocene deposits of the USSR" (p. 723). The paleontological material presented above indicates a position opposite to that which Abel (1905) expressed, and supported in our country by Bogachev (1938, 1939) and Barabash-Nikiforov (1940). This material for the time being attests only to the fact the huge Sarmatian basin, which included within its expanse the present-day Black Sea, (see Table 14), was populated by dolphins from the family Delphinidae, and not Phocaenidae during the Miocene period. *94

Of very great interest are relatively recent finds of fossil dolphin in the region of the present-day Caspian Sea where, it is well-known, there are no dolphins of any kind at the present time. These finds are confined to a geological period considerably later than the Sarmatian finds; namely, to the Upper Pliocene. They were discovered in the Apsheron Stage (see Table 14).

During the course of activities on Chelekene Island in the years

1901-1902, almsot an entire skeleton of a dolphin was discovered by A. P. Ivanov (1907). Andrusov (1923) speaks of frequent finds of dolphin remains in the middle and upper formations of the Apsheron stage on Chelekene. In the same work, Andrusov (1923) sets out the history of two skeletons (one of them found by Ivanov, 1907) which were sent to Abel in Vienna for analysis. However, Abel not only did not describe, but did not even consider it necessary to return them. Thus this very interesting material was lost to us.

In the years 1907-1908 on the same Chelekene, many disconnected bones of dolphin were discovered by V. N. Weber and K. P. Kalitskii (1911). This material was analyzed by A. N. Ryabinin (1908) and was determined by him to be the remains of the common dolphin, - Delphinus delphis L. Comparing this material with a skeleton of a present-day common dolphin from the Mediterranean Sea, Ryabinin discovered a great similarity in them.

Finally, Bogachev (1938, 1938a) described the remains of a fossil dolphin from the Apsheron Stage found in the vicinity of the city of Baku - the front half of a skeleton with a badly preserved skull. The author, without hesitation attributes this find D. delphis L. as well. The greatest breadth of the braincase of the fossil skull presented by Bogachev (1938) was a figure of about 150 mm. In the present-day Black Sea dolphin, this skull measurement is given by the following mean figures: 119.6-122.3 mm in the harbour porpoise; 196.3-199.0 mm in the bottlenose; 141.5-144 mm in the common dolphin. Within the material on the skull measurements of the present-day Black Sea dolphins, the following can be noted; 1) only one of 22 harbour porpoise skulls attains 131.5 mm in the above measurement; 2) only one of 62 bottlenose skulls attain 170 mm in this measurement; 3) of 52 common dolphin skulls, this measurement in some skulls is 150 mm, or figures close to that (see the skull measurements in the appendix).

These figures only confirm the accuracy of Kirpishnikov's conclusion (1951), who writes regarding Bogachev's (1938) identification that "the measurements and the shape of the teeth together with the breadth of the cerebral section of the skull presented by the author, suggest similarity between the fossill dolphin and the present-day D. delphis" (p. 1022). *95

Summarizing all of the paleontological material presented here, it is possible to draw two important conclusions.

1) During the Miocene Period, the vast Sarmatian Basin including within its expanse the present-day Black Sea, was populated by dolphins belonging to the family Delphinidae.

2) During the Pliocene Period, i.e. during a considerably later geological period, the basin situated on the location of the present-day Caspian Sea, was populated by dolphins very close to the contemporary common dolphin, i.e. Delphinus delphis L.

Bogachev, attributing the appearance of the dolphin in the then existing Caspian Basin to the Akchagylskii period writes: "We should nevertheless contrast the transmigration of Delphinus delphis L. with the appearance of the Akchagylskii fauna" (Bogachev, 1938, p. 49). In another of his works, Bogachev (1938a p, 81) attributes the appearance of the dolphin in the Caspian basin to the Akchagylskii epoch "simultaneously with the immigration of marine molluscs (Mactra, Cordium, Potamides). Perhaps certain shad penetrated through at the same time."

In fact, both during the period of the Akchagylskii basin, which was situated in the location of the present-day Caspian Sea, and during the time of the then Apsheronskii basin, there were connections with basins corresponding in time and situated on the location of the present-day Black Sea, i.e. the Kuyalnitskii and Chaudinskii Seas (see Table 14). Thus the hypothesis suggested by Bogachev (1938, 1938a) is quite probable.

A question can arise: in that case, why is it that fossil remains of skeletons corresponding to the Apsheronskii period for the Caspian Sea, were not once discovered in the region of the present-day Black Sea? The answer to that question, it seems to me, is that the Black Sea basin, beginning from the Chaudinskii period, was situated basically within its present-day boundaries (see Table 14, and Figs. 23, 24, 25). As a result, it is difficult to expect a discovery of fossil dolphins, beginning with the Chaudinskii period, in places not occupied by waters of the present-day Black Sea.

Thus, the paleontological materials provide a basis for assuming that the ancient Sarmatian Basin, including within its boudaries the present-day Black Sea, was populated during the Miocene Period by dolphins of the family Delphinidae, and during the Upper Pliocene, by dolphins ex- *96
tremely close to the contemporary common dolphin, i.e. Delphinus delphis L. To this should be added the fact that only this species of the Black Sea dolphin has certain morphological differences in comparison with the Atlantic form. Finally, the helminthological analysis, having disclosed in species of Black Sea dolphin a new genus of helminth, specific only to that species, also supports a more ancient isolation of this dolphin (see the previous section of this chapter).

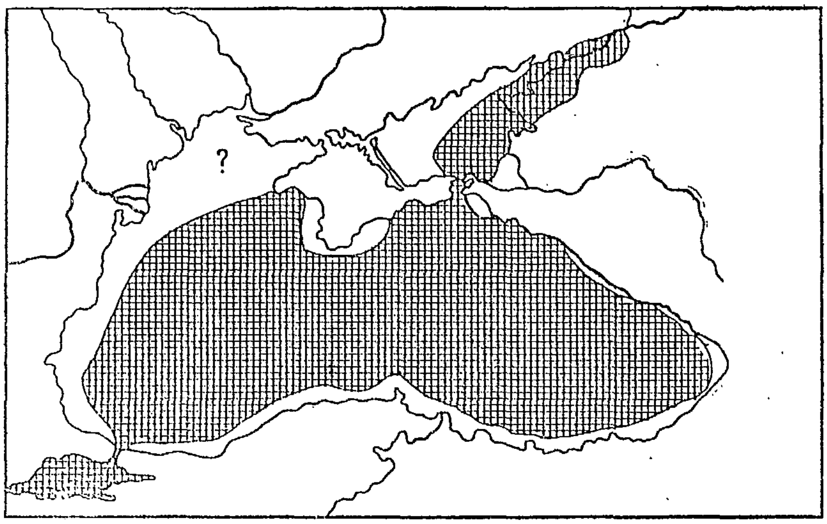

Рис. 23. Черноморский бассейн в чаудинское время
(по А. Д. Архангельскому и Н. М. Страхову).

Fig. 23. The Black Sea basin during the Chaudinskii stage (by A. D. Arkhangel'skii and N. M. Strakhov)

These considerations allow one to assume that Delphinus delphis ponticus can be considered a relict or, in any case, an aboriginal form in the basin.

Of course, this assumption can be met with many objections. P. van-Beneden (1892), for example, and in our time, Kirpichnikov (1952) consider that all Cetacea that inhabited the Black Sea basin in the past became extinct, and that all of the present-day fauna are already immigrants of the Quarternary Period. This position is based mainly on the fact that it is difficult to assume that the dolphin were able to survive all of the disturbances connected with the evolution of the Black Sea. Nevertheless, one can name a number of relict forms which react more sharply to a change in salinity and temperature and which have nevertheless survived to this day. In particular, Zenkevich (N. A. Bobrinskii, L. A. Zenkevich, Ya. A. Bierstein, 1946) points out in this regard: "In order *97 to understand the disappearance and the new reappearance of fauna in the deposits of the individual basins that replaced one another, it is necessary to consider it probable that these fauna survived in separate restricted sections of the basins and with a change in the regime of the basin in a direction favorable to them, they spread to all parts of the water body. Such 'refuges' must have existed for the Middle Miocene, Sarmatian, and later for the Pontic fauna as well" (pp. 190-191).

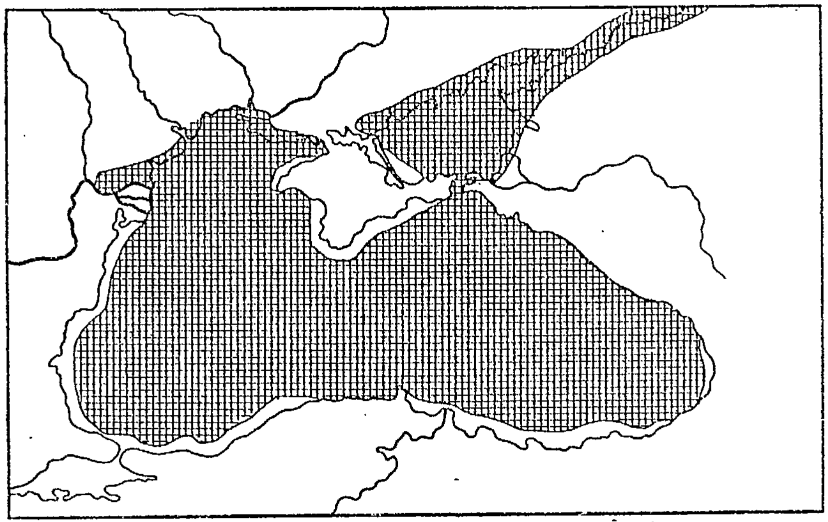

Рис. 24. Черноморский бассейн в древнеэвксинское время (по М. В. Муратову).

Fig. 24. The Black Sea basin during the Paleo-Euxine Period (by M. V. Muratov).

Another question may be raised: why did the dolphin in the Caspian basin, which undoubtedly existed in it become extinct, and those in the Black Sea basin survive to this day? It is difficult of course, to give an exhaustive answer to that question, however, one can point to the incomparably sharper fluctuations in the level of the Caspian Sea as one of the reasons. Moreover, the nature of the present-day Black Sea itself, to which the common dolphin is so ideally adapted (we will dwell on this in more detail in the third chapter) differs extensively from that of the Caspian Sea.

Other objections can of course be advanced against the hypothesis I have suggested. There is no doubt that the paleontological data which have a decisive significance in solving the issue of the development of the fauna are thus far so negligible that they do not as yet offer the possibility of passing over from the domain of assumptions to that of established *98 fact. Nevertheless, it seems to me that there are a sufficient amount of them to be able to substantiate such an hypothesis.

One of the elements supporting Abel's theory (1905) was the absence of the harbour porpoise in the Mediterranean Sea. Acknowledging this fact, Andrusov (1890a) considers that the harbour porpoise could have penetrated into the Black Sea from the Atlantic Ocean through the Mediterranean Sea during the glacial period when the climate of the Mediterranean Sea was more severe. With the subsequent conditions then, the harbour porpoise, having disappeared from the Mediterranean Sea survived in the Black and Azov Seas where the climate is more severe than in the Mediterranean. A similar point of view was expressed by Tsalkin (1938) who with reference to Sovinskii's (1902) data, points out many species characeristic of the boreal zone of the Atlantic Ocean which exist in the Black Sea, but are absent in the Mediterranean. These are certain annelids, copepods, isopods and decapods. Their presence in the Black Sea can be explained "only by the existence of boreal fauna in the

Mediterranean Sea during the ice age" (V. I. Tsalkin, 1938, p. 728), and further: "With the absence of glaciers and with the warming conditions in the Mediterranean Sea, the harbour porpoise which inhabited it became extinct due to the changes in the habitat. The Black Sea, on the other hand, and in part the Sea of Azov, due to their climatic and hydrological conditions which made them more like the boreal zone, proved to be more favorable for the existence of the harbour porpoise which survived in *99
these bodies of water up until our time as relict fauna of the ice age" (ibid.).

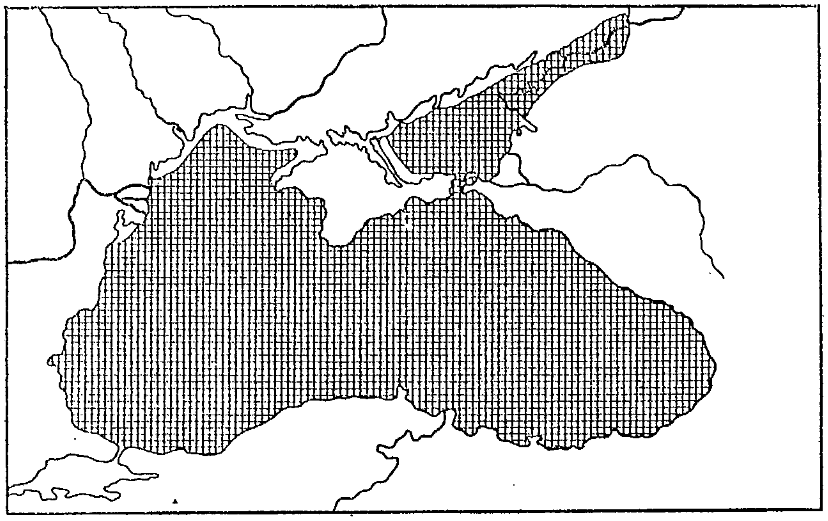

Рис. 25. Черноморский бассейн в карангатское время (по М. В. Муратову).

Fig. 25. The Black Sea during the Karangat Period (by M. V. Muratov).

Taking into consideration the discovery in the Black Sea harbour porpoise of two species of helminths specific to it and none in the bottlenose (S. L. Delamure, 1955), I am inclined to think that the harbour porpoise penetrated into the Black Sea somewhat earlier than the bottlenose.

In this case, adopting Andrusov's (1890a) and Tsalkin's (1938) point of view, one can assume that the harbour porpoise penetrated into the Black Sea basin immediately after the Mindelian glaciation when the first connection between the Black Sea and the Mediterranean was formed. Further desalinization of the Black Sea basin could not have had any destructive effects on this dolphin for even the present-day form, as is well-known, by no means avoids extremely desalinized bodies of water.

The bottlenose penetrated into the Black Sea later apparently, i.e. during the formation of the subsequent connection between the Black and Mediterranean Seas.

This is how, according to my notions, the present-day cetacean fauna of the Azov-Black Sea basin developed.

CHAPTER II

BIOLOGY OF THE DOLPHINS OF THE BLACK AND AZOV SEAS

1. A BRIEF SURVEY OF THE GENERAL MORPHOLOGY AND BIOLOGY OF THE DOLPHINS

Of all the aquatic mammals, we cannot name a single form in which *100 the adaptation to this environment has progressed as far as in the Cetacea (R. Kellog, 1938). It is not surprising, therefore, that for a long time these animals were relegated to the fish class even by Linnaeus in his famous "Systema Naturae".

Beginning with the external appearance, the entire organization of the Cetacea bears the features of a remarkable adaptation to life in the water. The torpedo-shaped body with the caudal peduncle flattened at the sides, ends in the horizontally arranged flukes of the caudal fin. The entire body of the animals is optimally smooth without anykind of protuberances which could impede movement in the water. Thus, in the dolphin as well as in all Cetacea, the hind limbs are reduced; the fore limbs are transformed into relatively short, streamlined flippers. The helices are completely reduced. The two nipples in the females are concealed in cutaneous pockets situated along the sides of the genital cleft and the reproductive organs of the males are situated in the body cavity. Thus a maximum streamline effect of the body is attained.

Only small rudiments of the pelvic bones, situated in the muscles remain of the hind limbs in the Cetacea. In the literature, there are very few indications of discoveries in the cetaceans of rudiments of the femur and shank, which of course, do not protrude externally. Only R. Andrews (1921) described rudimentary hind limbs in a humpback whale which protruded externally but had no cutaneous covering. The most interesting, and the only instance in world literature is a description by M. M. Sleptsov (1939a) of rudiments of actual pelvic flippers covered with skin in Black Sea common dolphin. These flippers were discovered in a completely *101 normally developed female, 150 cm in length, caught in the Yalta region in December of 1935. The flippers were located on either side of the genital cleft; the height of the right one was 3.4 cm, and the left one 1.6 cm. They were composed, according to Sleptsov (1939a) of bony and cartilaginous members of the rudiments of: the pelvic bones, femur, shank, the tarsus, metatarsus and the phalanges of the toes. One can judge as to how rare such instances are if only by the fact that lately, not less than 100 thousand specimens of Black Sea dolphin have passed through the hands of researchers, while the case described by Sleptsov remains the only one.

The fore limb [i.e. pectoral - Trans.] girdle in the dolphin has been preserved, although it is extremely shortened. Here, only the clavicle is absent. A pentadactylate limb forms the basis of the structure of the fore limb common to all mammals; although externally, the flippers of these animals, one would think, have nothing in common with a pentadactylate limb.

An analysis of the structure, function, the individual transformations and the genesis of the pectoral girdle of the common dolphin was at one time conducted by A. N. Druzhinin (1924). An accurate X-ray anatomical study of the structure of the fore limb of this species of Black Sea dolphin by G. G. Bokken (1946) appeared comparatively recently, which according with his data, is formed by a scapula, an extremely shortened humerus, ulna and radius, four carpals and five metacarpals, the first carpals and metacarpals fusing into a single bone. The author determines the phalanges of the digits by the formula: 2 8 6 3 1.

The skin of the dolphin, optimally smooth externally, is devoid of sweat and sebacious glands. It consists, as in all mammals, of two basic layers; the epidermis and the corium. Externally, the skin is covered with a special secretion of the epidermis which increases considerably the glide of the animal in the water. The work of physicists (V. Shuleikin, V. Lukyanov, I. Stas', 1937) showed that the streamlinedness of the Black Sea common dolphin is higher than that of the mullet and 5 times superior to that of the stellate sturgeon. In its hydrodynamic qualities, the dolphin surpasses even such a high-speed fish as the Atlantic bonito (*sarda sarda Bloch*).

It is interesting that in certain cetaceans isolated hairs are preserved on the head. G. Allen (1916) considers that these hairs have a tactile function, since their follicles are well innervated. In the Black Sea dolphin, isolated hairs occur only in embryos. They are situated in rows along the external edge of the maxilla on both sides and are very suggestive of the vibrissae of predatory mammals.

Over the entire body of the dolphins directly below the skin, there *102
is a thick layer of blubber, on account of which the commercial catching of these animals is basically conducted.

The musculature is basically composed of longitudinal muscles running lengthwise along the body of the animal toward the tail. The musculature of the limbs is very weakly developed. Thus, the principal organ of locomotion in the dolphin is the tail.

In the skelton of these animals in comparison with terrestial mammals, one is struck first of all by the insignificant role of tubular bones (there are no hind limbs and the bones in the fore limbs are extremely shortened). The bones of the skeleton are porous and are saturated with a large amount of fat which considerably decreases the specific gravity of the skeleton. This feature of the skeleton, including the thick layer of subcutaneous blubber facilitates greatly the bouyancy of the animal and decreases considerably its specific gravity. According to my calculations conducted in the spring of 1949 in Novorossiisk, the specific gravity of an adult common dolphin was equal to one, and in the new-born, the specific gravity was even lower. Due to the low specific gravity, an animal killed in the water does not sink during the period of maximum fatness condition, which is in the spring. In the fall, with a reduction in the fatness condition, the specific gravity of the animal increases and a killed animal sinks.

The respiratory openings situated at the end of the muzzle in all mammals, are shifted back in the dolphin; being situated practically in the area of the sinciput of the animal. In this way the osseous respiratory passages pass through the cranium almost vertically - from the top down. The short trachea develops into two bronchi connectiong to lungs consisting of a single lobe.

There is no connection between the respiratory passages and the buccal cavity, owing to which the dolphins can breathe without raising the muzzle out of the water. Priority in this issue belongs to our academician K. Baer (1826, 1836, 1864) who was the first to demonstrate the absence of a connection between the buccal region and the respiratory passages in Cetacea, excluding the possibility of water entering the respiratory passages from the buccal region. All of the works on this subject by foreign authors belong to a considerably later period. Baer (1864) also elucidated the nature of the fountains of whales. He considered that the fountains are formed as a result of the fact that the animal exhales the air at a time when the blowhole is still under water. The stream of air exhaled with great force takes along with it a spray of water, forming a fountain. Many authors, including contemporary ones, share this point of view of Baer's regarding the nature of the fountain of whales (G. Burmeister, 1868; F. Beddard 1900; G. Allen, 1916; P. Scholander, 1940; V. Arsen'ev and V. Zemskii, 1951, et al). However, Tomilin (1947) denies this explanation of Baer's considering that the fountains are formed as a result of the Cetacea taking air into the repiratory passages. Attri- *103 buting thermo-regulatory significance to this act, Tomilin calls these fountains "purifying" fountains.

Sleptsov (1952) characterisizes this point of view of Tomilin's as an "unfortunate fallacy". He considers that in toothed cetaceans the fountains "consist of fine drops of water heaved up by the sincipital process and raised up by a forceful stream of air exhaled by the lungs" (p. 130). My observations on the Black Sea confirm Sleptsov's point of view.

Inasmuch as only very tiny fountains of spray are observed in the Black Sea dolphins and fountains characteristic of other whales never occur, we can leave aside the consideration of the nature of the fountains in whales and not introduce other points of view on this issue extant in the literature.

The external respiratory opening, of which there is only one in the dolphin and is called the "blowhole", is closed exteriorly by a muscular sphincter protecting the respiratory passages from the entry of water into them. Nevertheless, this does not exhaust by far those remarkable features of the morphology of the respiratory system which are innate in the Cetacea. From the enormous amount of literature on this subject, we will confine ourselves to indicating the basic works to which the works of Baer already mentioned earlier belong first of all. Also well-known are the works of H. Beauregard and G. Panchet (1886-1887), B. Rawitz (1900), B. Howell (1927, 1930), G. Wislocki (1929), A. Laurie (1933), H. Raven and W. Gregory (1933), E. Slijper (1936), W. Bonin and L. Beolanger (1939), Wislocki and Beolanger (1940), P. Scholander (1940), Tomilin (1947) and Sleptsov (1948, 1952). Many of these studies are of enormous interest to us since they concern those species of dolphin to which this present work is devoted. My dissections of the respiratory passages of the Black Sea dolphin fully confirm the data in this regard extant in the literature.

Besides the exterior muscular sphincter which closes the animal's blowhole from the outside, inferior to it are two more diverticula located one below the other which also close the respiratory tract. But the most remarkable is a series of valves discovered in the bottlenose by G. Wislocki (1929) located on minute bronchioles which enter into the alveoli of the lungs. Located some distance one from the other, they completely close the lumen in the bronchioles during a respiratory pause, opening only during the respiratory act. Thus, the alveoli of the animal's lungs are blocked to the entry of water into them by the entire system of various valves.

In the lung tissue, not only surrounding the bronchioles and the blood vessels, but also in the alveoli themselves, there is a profusion of elastic fibres which stretch during inhalation and contract during exhalation. S. Engel (1954) described this elastic tissue in the alveoli of whale lungs, and also the alveolus itself, which is enormous compared to the alveoli of terrestial mammals, including those of elephants. The number of alveoli in the lungs of cetaceans is large as well. While there are on the average of 150 million alveoli in man, in a harbour porpoise with a length of 1.5 m, F. Schultze (1906) counted 437 million alveoli.

The next remarkable feature in the structure of the lungs of the Cetacea is the cartilaginous tissue surrounding not only the bronchi, but the bronchioles as well, right up to their entrance into the alveoli. It is quite obvious that this adaptation is aimed at resisting the pressure which the animal experiences during submersion. Scholander (1940) considers that this adaptation protects the Cetacea which dive to great depths from caisson disease. In his opinion, the air under the influence of the pressure is first squeezed out of the alveoli, but is retained in the bronchioles and bronchi, as a result of the sturdiness of the walls which impedes the diffusion of nitrogen into the blood in amounts that would have produced caisson disease during diving by the animal. The features in the structure of the lungs of the Cetacea mentioned above present a strange fact at first glance. Thus, for example, in any dead animal, the lungs always collapse while in the dolphin, they always retain a certain amount of air. When I (something which was already mentioned in passing in the introduction) attempted to squeeze the air from a lung of a dead Black Sea dolphin, I reached a point where I put it under a board and stood on it. The lung, during this process, would spring like a tire but was not freed of air. I got the impression that in order to free the lung of the air it contained, it would be necessary to destroy it completely. Such was the sturdiness in the structure of the lungs of these animals.

In connection with the noted features in the structure of the lungs, it is extremely noteworthy that in the dolphins, of the abdominal muscles, the expiratory muscles were considerably better developed, while the inspiratory muscles were less developed. As a result, fundamental to the act of breathing in contrast to terrestial mammals, is expiration.

To the features on the structure of the respiratory system, one should also relegate the large number of free ribs. Of 14 ribs in the *105 Black Sea common dolphin, only the first four are attached to the sternum. The remaining 10 ribs are asternal. The first projection of the diaphragm attaches to the last sternal, i.e. the fourth, rib. Thus, 11 ribs are connected with the diaphragm which shortens the sterno-costal section of the thoracic cage and lengthens the posterior costo-diaphragmatic section. As a result, the type of respiration is to a greater degree abdominal rather than thoracic. This feature of the thoracic cage allows for its capacity to be changed considerably.

The structure of the cranium of the dolphins is also highly unique and differs sharply from the usual structure of the cranium of other mammals. Here first of all, one's attention is drawn to the fact that there is an extreme shift of the nasal passages backward. The respiratory passages in the cranium run almost vertically and the mesopterygoidal foramena exit at the base of the cranium. The occipital bone, rising upward, extends forward compressing the parietals. Here, in adult individuals, a high crest is formed. Such a development in the occipital bone is caused by the fact that the powerful dorsal muscles are attached to it. The facial section of the cranium surpasses the length of the cerebral section forming a long extened snout (or rostrum). The maxillaries and premaxillaries, expanding intensely during growth, cover almost entirely the frontals (see Figs. 5, 6). In the structure of the cranium, one's attention is drawn to the clearly marked asymmetry peculiar to all toothed whales, i.e. the bones of the left half of the cranium are markedly smaller than those of the right half.

The asymmetry of the head of the Black Sea common dolphin aroused the curiosity of physicists who explained the reason for this asymmetry. V. V. Shuleikin, studying the kinematics of the dolphin, originated a theory of locomotion in the dolphin on the basis of mathematical calculations confirmed by experimental data. According to this theory, the animal moves in the water in a manner similar to a screw with a left-hand thread, a "steadily increasing wave, polarized according to an ellipse or circle, running along the body of the dolphin (from head to tail)" (V. V. Shuleikin, 1941, p. 717). Proceeding from this theory of locomotion and corresponding calculations, Shuleikin comes to the conclusion that if the dolphin's head were symmetrical, the animal, during forward motion by virtue of the nature of the latter, should according to the laws of physics, keep revolving around its longitudinal axis, and only the asymmetry of the head saves the dolphin from this rotary motion. Objections on the part of biologists, in my view, can be raised only with regard to the way the experiment was conducted. The point is that in photographing the motion of the dolphin with a movie camera, the animal was placed in a stall in such a way that the tail section protruded through a round hole in a board. In order to elicit a movement "the dolphin was given a stimulus," writes the author, "by means of an electric current (the electrodes were inserted into its mouth - the current was 110 v) or artificially induced stoppage of respiration (a hand was placed over the blowhole for a certain period of time). In both instances the dolphin should have performed those exact motions which it performs in protecting itself from pursuit" (Shuleikin, 1941, p. 717). It is difficult to agree with the latter position. If we were to take any mammal and place it in situation similar to that of the dolphin and begin to irritate it about the face area with an electric current or by squeezing its nostrils, then it is difficult to imagine that this animal would attempt to go forward. Rather, one can assume that it will try to withdraw from the stimulus coming from the front by jerking to the sides or backwards. However, the objection concerns only the organization of the experiment and not Shuleikin's theory as a whole. *106

Shuleikin's views were subjected to criticism on the part of A. S. Narkhov (1937) and Sleptsov (1939). The former, having analyzed the morphology of the muscles of the caudal section of the Black Sea common dolphin and the bottlenose, demonstrated the absence here of specific differences. Moreover, Narkhov considers that the function of the individual muscles is such that it allows the dolphin to move the caudal section in a vertical plane. However, Narkhov himself writes about muscles which draw the tail of the dolphin to the sides, i.e. in a horizontal plane. Nevertheless, in a subsequent work Narkhov (1939), basing himself on experiments as unconvincing as Shuleikin's experiment, engages in polemics with the latter maintaining that the forward motion of the dolphin is caused by rapid movements of the caudal fin of the animal upwards and downwards, i.e. only in a vertical plane.

Sleptsov (1939), having thoroughly analyzed the issue of the asymmetry in the craniums of toothed cetaceans on the basis of the Black Sea dolphins and beluga, disputes Shuleikin's theory on the asymmetry of the dolphin cranium, calling it mechanical. Sleptsov considers that "the asymmetry of the cranium of toothed whales appears as a result of the cessation of the function of olfaction which led to a commencement of the reduction of the olfactory nerves, the nasal labyrinth and the nasal bones. In one of those stages of this process, an acceleration in the reduction of the left olfactory nerve and the lobe occurred, which was correlatively reflected in the reduction in size of the left hemisphere of the brain. As a result of the advanced changes in the nervous system, an asymmetry in the cranium emerged" (Sleptsov, 1939, p. 384). *107

Still, Sleptsov does not explain why the acceleration in the reduction of the left olfactory nerve and the olfactory lobe occurred as compared with the right ones. Thus, his work (1939) does not solve the issue: what then is the effect and what is the cause? Consequently, this work was not able to disprove Shuleikin's theory.

The objections of Narkov and Sleptsov prompted one of Shuleikin's co-workers to bring forward new evidence in support of his theory. Thus, I. I. Stas' (1939) describes a specially designed automatic recording device which was attached to the body of the dolphin with which the latter was released into the water. The recording device registered the dirction of the movement of the caudal section of the dolphin's body. Arguing with Narkhov (1939), the author writes that if the forward motion of the dolphin was caused by movements of the caudal fin only upwards and downwards, then it is easy to compute that "for the performance of the act of locomotion according to that theory, the dolphin would have to develop such an enormous frequency of movements that it would drone like a bumble bee while it was in motion" (p. 534). As a result of the conducted experiments, Stas' (1939a) concludes that during the dolphin's locomotion in the sea, a wave, polarized according to an ellipse not too different from a circle keeps constantly running over the body of the dolphin" (p. 669).

Reference to Shuleikin's (1935, 1941) theory on the locomotion of the dolphin is also made by A. Woodcock (1948) while describing a case he observed in the Gulf of Panama when a dolphin was swimming before the bow of a ship proceeding at a speed of 10 knots without any visible movements; the dolphin swimming in such a position not only on its abdomen when the movements of the tail could simply have been unnoticeable, but on its side as well, when movements of the tail could have been noticeable. The author onbserved such swimming "without movement" at a distance of 304 m. The note ends in a question: has anyone seen such swimming by a dolphin, and what kind of explanation can be given to this phenomenon? L. Mathews (1948) responded to Woodcock's question, having reported that on January 6, 1948, in 55°15' south latitude and 39°05' east longitude, he observed such swimming by dolphins which he explains by the fact that the frequency of the movements of the tail during locomotion are very great and the churning on the surface of the water prevents accurate observation. Now however, after Woodcock's observation, this explanation in his opinion becomes superfluous.

It seems to me that the observations of these authors can be explained by some sort of optical illusion for it is impossible to assume that an animal can travel in the water without applying any muscular effort, especially if one recalls J. Gray's (1936) calculations according *108 to which the work performed by the dolphin during locomotion at a speed of 10 m/sec is seven times greater than the work of the muscles of terrestial mammals travelling at the same speed.

Turning to the sense organs in the dolphin, one should first of all note the absence of olfaction. While in the baleen whales Kükenthal (1889) and Weber (1928) still found vestiges of olfactory organs, in the toothed cetaceans, according to the data of Kükenthal (1889), Abel (1928), Weber (1928), Mal'm (1933) and Sleptsov (1938), the olfactory organs are lost completely. Mal'm (1938) also points to the absence of taste bulbs in the Black Sea common dolphin as well.

Vision in the dolphins is developed to a considerable degree. The anatomy of their eyes was studied in considerable detail by O. Pütter (1902), therefore we are referring those interested in the subject to the above work.

Incidentally, O. V. Lindholm (1888) had already written about the fact that whales can see for 18 sazen. Kellog (1928) restricts the range of vision in whales to 20 meters. He considers that due to the spherical shape of the crystalline lens and the reduction in the ciliary muscles, accomodation is absent in the Cetacea and that the animals cannot see while out of the water. Photographs by McBride (1940) on which it is illustrated how in the Florida Oceanarium dolphins jump out of the water and take a fish off of a board out in the open, attest to the inaccuracy of such a conclusion. In photographs on the training of bottlenoses in the same oceanarium presented by Dillin (1952), it is clearly visible how the animal, jumping out of the water to a height almost equalling its body length, takes an object which is out of the water into its mouth (see Fig. 22).

It is completely incomprehensible as to what led the foreign authors (Pütter, 1902; Kellog, 1928; Howell, 1930) to the conclusion regarding the complete immobility or very little mobility of the eyelids in the Cetacea. I personally had the occasion many times to observe the reaction of the eyelids in the dolphins to a finger as it approached the eye.

In animals which have been out of the water for a long time, a secretion is discharged from the corners of the eyes which the fishermen usually take for tears. However, the cetaceans have no lachrymal glands. This secretion is apparently the product of the activity of the Harderian gland, enlarged in cetaceans and evidently serves as a means of protecting the eyeball from adverse and constant action of salty sea water on it. Kellog (1928) notes that in cetaceans that dive to great depths, the cornea is developed to a relatively greater degree which imparts greater "illuminating power" to the eye. *109

In the considerable layer of connective and vascular tissue surrounding the eyeball and optic nerve of cetaceans, Freund (1932) sees an adaptation to changes in pressure on the eyes by the external environment.

Hearing in dolphins, without doubt, is the most highly developed sense. However, it should be noted that here, the medium of habitiation of the animals itself contributes to better propagation of sound than that which occurs in the atmosphere. In connection with this, the fishermen on the Black Sea have a unique practice called a "telephone". When it becomes necessary to change the direction of the course of a school, one of the fishermen, from a boat heading in the same direction as the school, takes two rocks and lowering them into the water, strikes the rocks together. I have on many occasions observed how a school of dolphin proceeding at a considerable distance and with great speed, will instantaneously, as though on command, swerve away from such a "telephone."

It is interesting that Th. Beale (1839) had already noted that sperm whale hear each other from a distance of about 7 miles, and Lindholm (1888) maintains that the bowhead whale hears the slightest noise produced in the water at a distance of a mile away from it.

One should also relegate to the area of auditory reactions the indications of C. Townsend (1916) and O. St (1916) on the New York aquarium and McBride on the Florida oceanarium who indicate that a bottle-nose will not react to a fish lying on the bottom but quickly lunges toward a fish thrown into the water.

It should be noted that with such a development of auditory perception in the dolphin, as in all cetaceans, the pinna is completely lacking. The external auditory meatus, preserved only in the toothed cetaceans, is so small in our Black Sea dolphins, for example, that a match stick passes through it with difficulty, and that to find it on the body of an animal is no easy task. Thus the opinion established in literature that the transmission of sound is accomplished mainly by means of vibrations of the cranial bones is evidently correct.

Almost all of the cetaceans are gregarious animals and keep to schools which at times form huge concentrations. In connection with this,

the signal system of the animals is of great interest. The most complete analysis of this subject belongs to Tomilin (1947, 1947b, 1954a) according to whose data the dolphins actually emit sounds resembling a squeak and at times a creak. These sounds are emitted by the blowhole, not un- *110
like the way a person whistles, i. e. forcing air through a slit of the valve which closes the blowhole. My observations on the Black Sea can only corroborate Tomilin's data.

While on land the dolphins squeak very rarely. The young individuals squeak more often. However, when I dived down to where the seine net was already closed and where the dolphin tangled in the net were, their unique squealing could be heard continuously. Thus, Tomilin (1947, 1954a) was apparently correct when he writes that the bubbles of air in the water by which, as R. Collet (1886) points out, it is possible to track the underwater course of whales, are the result of the animals' signals in the water. Consequently, A. Ingebrigtsen's (1929) explanation, in accordance with which these bubbles are released by the whales for flushing out crustaceans, has to be acknowledged as inaccurate. Apparently, Devedzhan (1926) and Mal'm (1938) were also mistaken when they took these bubbles for gases issuing out of the rectum of the Black Sea dolphin.

There is a large amount of material regarding the sounds emitted by cetaceans while out of the water. Some authors indicate that these are "brassy-metallic sounds, others compare them to the sounds of musical instruments or soft whistles. It is precisely such sounds emitted by baleen whales that Beddard (1900), Kurakami (1930), Mathews (1938) and others write about. V. Skoresbi (1825) and also Gray (1886), S. Maximov

(1871), van-Beneden (1888), K. Ditmar (1901), E. Racovitza (1903), J. Millais (1906), J. Liouville (1913), G. Miller (1930), N. Nielsen and M. Degerböll (1930), H. Hale (1939), and others had already written on the sounds emitted by toothed cetaceans. Our own well-known traveller of the Far East, V. K. Arsen'ev (1925) writes the following in this regard: "The cry emitted by the beluga resembles a short muffled lowing. The fishery manager I. F. Solovei, recounts how one day in the summer of 1920, a beluga was caught in the Taui River which the workers tied by the tail and set loose in the water. It moaned all night and that moaning of the beluga's was audible on the shore despite the fact that a breeze was blowing from the shore into the sea" (p. 106-107). McBride (1940), on the basis of observations in the Florida oceanarium, writes about the exchange of whistled signals between alarmed bottlenoses.

It is no coincidence that I presented such a large amount of literature since many zoologists even up until the present time do not believe in the reality of the existence of sound signals in the cetaceans in view of the fact that these animals have no vocal chords. Nevertheless, cetaceans do emit sounds, and their organ for producing sound signals is the blowhole. One can hope that with the technology that exists today when there is the possibility of listening to and even recording the sounds, the issue of sound signals in the cetaceans will receive more thorough analysis. *111

Tomilin (1935, 1947), basing himself the possibilities offered by the above, considers it possible to employ a calling device during the commercial fishing of cetaceans. In connection with this, he makes reference to P. Porfir'ev et al. (1904), who indicates that the Turks call the dolphins by whistling to within shooting distance of the felucca. However, I can only certify that I did not have the occassion to observe anything of the kind, although in 1935 I sailed with Turkish fishermen throughout an entire season in the region of Batumi (S. E. Kleinenberg, 1941).

An interesting feature observed in the behaviour of dolphins is their following of vessels, at times for very long periods of time. This feature is apparently characteristic of many cetaceans. Andrews (1916), for example, describes the tailing of a vessel by a blue whale over a period of 24 days. A. Rodler (1902) also describes prolonged following of vessels by whales. Skoresbi (1885) noted this feature in narwhals; C. Scammon (1874), Millais (1906) in blue whales; H. Mosley (1892), Racovitza (1903), Allen (1916) in humpback whales; Gray (1882), D. Lillie (1915) and Miller (1918) in bottle-nose whales and dolphins. All of this material, together with personal original observations was correlated by Tomilin (1937, 1947), who assumes that this phenomenon in cetaceans can be explained as an instinct for following a body swimming in the water so necessary for young animals still feeding on milk and who must always follow the mother. However, another hypothesis extant in the literature: namely, that in this case the animals are attracted to the food which is scared up in the water by the propeller of the ship, is also entirely possible. In the Black Sea dolphins, at least in the common dolphin, such following of vessels is a common phenomenon. I think that it is a result of pursuit after food.

Yet another quite characteristic feature in the behavior of the Black Sea dolphins is their leaping out of the water. Sometimes these leaps during rapid motion are followed by a whole series of leaps, one after another. The fishermen in such cases say that "the dolphins are playing," considering that these "games" of the dolphins always occur before a gale. In 1946 in the Anapa region, I repeatedly had occasion to become convinced of the accuracy of these observations. It is interesting that Pallas (1811) had already written in this regard that the appearance of *112 dolphin in the open sea heralded an approaching storm (v. I, p. 284).

This feature is peculiar not only to the dolphin but to all of the other cetaceans, regarding which Scammon (1896) and M. Vasil'ev (1891), and many others had already written. This material was also correlated by Tomilin (1937, 1947). The reasons for this peculiarity in the behavior of cetaceans are still not clear even until the present time. In the literature, the most diverse explanations are given to this phenomenon. Thus, for example, F. Fabricius (1870), G. Guldberg (1887) and Beddard (1900), consider that the whales leap in order to free themselves from external parasites. However, this opinion cannot be considered well-founded since leaps are observed in the Black Sea dolphin as well which are free of external parasites.

Racovitza (1903) explains the leaps of whales as an instinctive need for the animals to stretch and Zenkovich (1936), thinks that they take these leaps for the purpose of stunning fish. However, these points of view are also not corroborated by facts: the Black Sea common dolphin, for example, makes these leaps always when in motion, not feeding at all during that time. I will not attempt to explain this phenomenon.

Despite the presence of vast amounts of literature containing a colossal amount of the most diverse biological observations of cetaceans, observations on sleep in these animals in natural conditions are extremely few. This was noted at one time by V. G. Heptner (1930) as it applies to the beluga. Apparently this is why Racovitza (1903), Miller (1906) and some others came to the conclusion that whales do not sleep at all. R. Collet (1886), G. Buchet (1895) and certain others consider that whales sleep under water lying on the bottom, and Vasil'ev (1891) thinks that whales are able to lie on the bottom for a long time and sleep, sometimes retreating even under the ice.

For a number of years while sailing continuously along with the dolphin in the eastern region of the Black Sea (from Batumi to Yalta), I did not once observe sleeping dolphins. However, according to one of the most experienced brigade foremen, A. P. Pritula, he had occasion once to observe, usually around 11:00 - 12:00 in the morning, completely still bottlenoses sleeping in the uppermost layer of water. This observation of Pritula's fully agrees with Q. Olsen's (1913) and Gray's (1927) encounters of sleeping whales. Finally, according to McBride's observations in the Florida Oceanarium (1940), cetaceans sleep in the uppermost layer of water at night as well as during the daytime. The author presents a photograph of a sleeping dolphin.

In conclusion to this section, we will dwell on the ecological classification of the Cetacea. *113

The first attempt in this direction was made by D. Eschricht (1849), establishing within the Cetacea ichthyophagi, planktophagi, sarcophagi, and teuthophagi. Racovitza (1930) added phytophagi to these four types. Such a division according to food composition is of couse sketchy. In the final analysis it led Liouville (1913), for example, to a point where he had falling under one type of ichthyophagi all of the dolphins, including the sei whale and the finback whale in which fish is by no means the principal food. Moreover, I will note that if such a division were to be accepted, then all of our Black Sea dolphin would be combined into a single type whereas they differ sharply from one another according to their feeding nature.

A more detailed similar classification was developed by Tomilin (1947, 1954), dividing the Cetacea into two adaptational types: the filterers and the prehensors. The first type corresponds to the baleen or whalebone whales, while the second - to the toothed cetaceans. Within the first type the author establishes three adaptational forms - microplanktophagi, macroplanktophagi or planktoichthyophagi, or benthophagi; within the second - seven adaptational forms: ichthyophagi, benthoichthyophagi, teuthophagi, sarcophagi, the fluvial benthoichthyophagi, fluvial benthophagi and phytophagi.

Our Black Sea dolphins, in accordance with this classification are combined into two adaptational forms: the common dolphin belongs to the ichthyophagi and the bottlenose and the harbour porpoise - to the benthoichthyophagi. Such a division more accurately reflects the true position, a fact that will become apparent from the following section of this chapter.

Trans. note: I have underlined many of these forms, transliterated directly from the Russian, which I assume must exist for the purpose of differentiating the various forms according to their nature of feeding, but which I had difficulty in confirming in Websters, for example. In any case, the terms themselves I think are self-explanatory and need no further explanation.

2. NUTRITION[1] AND FATNESS[2] IN THE DOLPHINS

A review of the biology of the dolphins under discussion begins with nutrition not as a conicidence. Having paramount significance for the animal itself, nutrition at the same time determines the basic, fundamental associations with the surrounding environment. It can be said that nutrition of any aquatic animal determines its role and significance in the life of the water body it inhabits. Finally, the quantity of the food base determines their distribution and migrations. Consequently, the study of the nutrition in the economically valuable animals also has an applied significance, inasmuch as a rationally organized industry cannot be conducted blindly, i.e. without the knowledge of the distribution and migrations of the animals. It is not coincidental that the study of nutrition remained as an independent topic in the program of activities of the VNIRO expedition which was discussed in the introduction. *114

We will begin the review of nutrition just as the other aspects of the biology of the Black Sea dolphin with the most numerous, principal commercial species; namely, the dommon dolphin.

Literary data, even the most recent, on the nutrition of this dolphin

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[1] Trans. note: It is always difficult to translate the Russian term pitanie as a simple concept such as "feeding" for example. Ricker (p. 181) perhaps gives the best definition of this term when he says that this term seems to convey the ideas of "food", "feeding" and "nutrition" simultaneously. The term "nutrition" seems to be used more frequently in translations of Russian material when pitanie is not used in the obvious sense of "active feeding".

[2] Trans. note: I considered using Ricker's (p. 262) definition "condition" for "upitannost" however, firstly - the term only applies to fish, i.e. "(a measure of fatness and fullness of a fish)". Secondly, since the author himself qualifies the term upitannost' as it applies to the dolphin later on and according to which this term seems to have a narrower meaning; namely, only the amount of subcutaneous fat layer, disregarding the general fatness of the entire organism, I have decided to use the term "fatness" here to refer to upitannost'.

outside of the Black Sea are astonishing in their scantiness and their much too general nature. Thus, Freund (1932) and Henntschel (1937) indicate that in the Atlantic Ocean it feeds on fish and cephalopods. F. Fraser and T. Norman (1937) note this dolphin as a typical ichthyophage. Moreover, it was still Lesson (1828) who had found flyingfish and octopus in the stomachs of the common dolphin inhabiting the Atlantic Ocean. P. van-Beneden (1889) pointed out that this dolphin feeds on small fish and that near the coast of Brittany it can be seen regularly pursuing schools of sardines.

In the North Sea, the common dolphin, judging by the information reported by V. Haake (1902), feeds primarily on shad.

There are some data regarding the nutrition of this dolphin near the coasts of Australia and Tasmania. Thus J. Pearson (1936) mentions in passing that he had the occassion of discovering up to 15,000 fish otoliths in the stomach of one dolphin, Unfortunately, the author does not indicate precisely what kind. H. Scott and K. Lord (1921) report that in the stomachs of adult dolphin, they discovered large numbers of corneous jawbones of cuttlefish, and in the immature individuals - spines of Spantangus. This confirmation is the sole indication regarding the feeding of the common dolphin on echinoderms.

Data on nutrition of the common dolphin in the Mediterranean occur in P. Fischer (1881) who notes that he found many small cavalla in its stomachs.

R. Legendre (1926) points out that in the stomach of a dolphin caught in 1926 near the Spanish coast, 15, 190 otoliths, belonging mostly to Scopelus were discovered. The author personally discovered a hundred cephalopod rostrums and also undigested squid in the stomach of a dolphin in 1925. The latter discoveries led Letendre to the conclusion that this dolphin feeds on non-commercial fishes.

Information to the contrary indicating the feeding of the common dolphin on just commercial fish in the Mediterranean Sea is reported by G. Police (1934). Describing the use of this dolphin during fishing activities in the Gulf of Naples, Police points out that the basis for this is the fact that anchovy and sardines during the winter season descend to the bottom, or at least to a depth inaccessible to the fishermen. The *115 fishermen then, having sailed out to begin the catch, search the sea for dolphins and having noted them, follow them until the animals begin to make deep dives thereby flushing out the fish to the surface of the water. The fishermen then sail up to the spot where the fish had surfaced and in peaceful co-operation with the dolphins catch the fish with nets, catching in this way 13-14, even 15 quintals (a quintal is equal to 105 kg).

Describing similar fishing activities on the basis of personal participation, the author points out that the anchovy and the sardines are caught in such a manner usually in the winter season while mackerel are caught during the summer. Besides these fish, according to Police (1932), herring and sometimes even mullet are caught in the same manner. As a result, the dolphin in the Mediterranean Sea feeds on all of the fish mentioned here.

The basic data on nutrition in the common dolphin outside of the Black Sea is limited to this, proper.

There are indications in N. Ya. Danilevskii (1871) on the nature of feeding of this dolphin in the Black Sea who writes that the dolphin pursue schools of anchovy. I. Arnold (1896), Silant'ev (1903), Dinnik (1910),

A. S. Kravchenko (1932) and others, indicate the same thing.

Mal'm (1932, 1933) indicates a greater diversity in the food of this dolphin, naming anchovy, the "tyul'ka"[1], shad, mackerel and crustaceans. The author does not present the Latin names therefore it is impossible to understand which "tyul'ka" exactly he is talking about. It is possible that after the example of the fishermen, he calls a sprat a "tyul'ka".

Later, Mal'm (1933a) also includes blennies, wrasse and shrimp in the food of the common dolphin.

We will not dwell here on information in the form of a diary reported by N. Dudin (1930), P. Igorev (1931) and certain others that are extremely confusing and therefore absolutely unreliable.

Thus, judging by the literary data, a rather considerable diversity in the food of the common dolphin can be considered as established. As we can see, pelagic fish are of primary importance in the nutrition of the animal both in the Black Sea and in other basins, the majority of authors considering the anchovy as the basic food in the nutrition of the dolphin in the Black Sea.

Participation in the Black Sea VNIRO expedition enabled me to have at my disposal a relatively large amount of material on the nutrition of the Black Sea common dolphin collected in various locations during a two year period. This material, as I have already indicated (S.E. Kleinenberg, 1936, 1937, 1940), restricts the food of the common dolphin to the following species: *116

anchovy - Engraulis enchrasicolus L.;

pelagic pipefish - Syngnathidae[2]

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[1] Trans. note: According to Ricker, tyul'ka can be the Azov tyul'ka (Clupeonella delicatula delicatula); the "Kuchurgan tyul'ka" (C. delicatula cultriventris) or the Mediterranean sprat (C.sprattus phalericus).

[2] The family is given for this item since it is not always possible to

sprat - Sprattus sprattus phalericus (Risso);
haddock - Odontogadus merlangus euxinus (Nordm.);
cavalla - Trachurus trachurus (L.);
surmullet - Mullus barbatus ponticus Essipov;
bluefish - Pomatomus saltatrix (L.);
and of the crustaceans - the marine cockroach - Idothea algirica Lucas.

I personally did not come across once the mullet, mackerel, blenny and wrasse indicated in the literature. Once a shad - Caspilosa sp. (?) - was discovered, however I am not including it in the food since isolated finds in the stomachs of the dolphin of one or another organism do not as yet provide a basis for speaking of them as components, the more so considering that objects clearly inedible are often discovered in the stomachs of the dolphin: coal slag, pieces of wood, bird feathers, cherry pits, the remains of the paper bag in which they were discarded into the sea etc. Once in the Yalta region, even a small bouquet of roses was discovered in the stomach of a dolphin.

All of this indicates that in the feeding of the dolphin, visual perception is of primary importance.

Besides the enumerated food objects, the following molluscs were on occasion discovered in the stomachs of dolphins: Nassa reticulata L., Mactra subtruncata Da-Costa, Coliptra hinesis L., Guoldia minima Montagu, Venus gallina L., Modiola adriatica Lamarck, Mytilaster sp.? Fellina fabula Granovius.

Are they considered part of the food?

I came across molluscs in both the beluga (1932) as well as in the

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determine the species from the remains in the stomachs of dolphins. Nevertheless, on the basis of certain data it can be corroborated that the dolphin feeds on Syngnathus schmidti Popov and Syphonostomus typhle L.

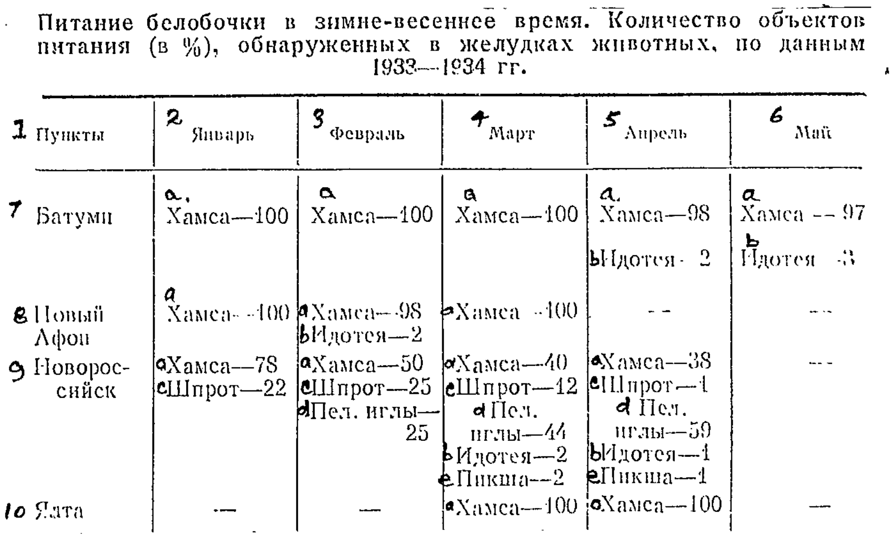
Black Sea bottlenose (1936, 1938). Nevertheless, I do not think that they are the food of these dolphins, and their presence in the stomachs is explained by the benthonic nature of feeding in the animals. The molluscs are snatched up apparently together with the benthonic food, or else they enter the stomach via the fish who feed on these molluscs and who in turn are the food of the dolphin. The common dolphin, on the other hand, feeds mainly on pelagic forms and the presence of molluscs in its stomach coincides with the presence there of only anchovy.

Also the fact that molluscs occur in the stomachs of the common dolphin always with complete, unopened shells and generally in insignificant *117 numbers, is an indication that molluscs are an incidental component of the stomach contents. On the other hand, a definite timing in the finds of molluscs in the stomachs of dolphins is observed. Thus, in all of the localities, the molluscs were discovered in March and in April.

Proceeding from the fact that the occurring species of molluscs are characteristic of sandy bottoms, and the fact that they are discovered during a specific period of time - in the spring - i.e. exactly during the time when the anchovy approach the shores and sometimes descend to the bottom, it is possible to assume that the dolphins snatch up the molluscs together with the anchovy. There are quite specific seasonal changes in the feeding habits of the common dolphin. Thus, in the winter, the basic, and in essence, the only food of the dolphins, especially near the southern Caucasian coastline, is the anchovy. During the summer, the food becomes more diverse, at least in the littoral zone. We will corroborate the above with Tables 15 and 16.

Table 15

Food of the common dolphin during the winter-spring period. The number of food objects (in %) discovered in the stomachs of the animals based on the data of the years 1933-1934.



Питание белобочки в зимне-весеннее время. Количество объектов питания (в %), обнаруженных в желудках животных, по данным 1933—1934 гг.

1 Пункты	2 Январь	3 Февраль	4 Март	5 Апрель	6 Май
7 Батуми	a Хамса—100	a Хамса—100	a Хамса—100	a Хамса—98 b Идотея—2	a Хамса—97 b Идотея—3
8 Новый Афон	a Хамса—100	a Хамса—98 b Идотея—2	a Хамса—100	— —	— —
9 Новороссийск	a Хамса—78 c Шпрот—22	a Хамса—50 c Шпрот—25 d Пел. иглы—25	a Хамса—40 c Шпрот—12 d Пел. иглы—44 b Идотея—2 e Пикша—2	a Хамса—38 c Шпрот—1 d Пел. иглы—59 b Идотея—1 e Пикша—1	— — —
10 Ялта	—	—	a Хамса—100	a Хамса—100	—

Key to Table 15:

1. Localities 2) January 3) February 4) March 5) April 6) May

7) Batumi 8) Novii Afon 9) Novorossiisk 10) Yalta

a) Anchovy b) Idothea c) Sprat d) Pelagic pipefish e) Haddock

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The data presented in the Tables characterizes the food of the common dolphin in the littoral zone where it was caught commercially in the years 1933 and 1934 not more than 10 miles offshore. According to Tsalkin's data (1938a), in the open sea during the summer, this dolphin feeds almost exclusively on sprat which amounts to 96% and even 98% of the contents of the stomachs.

Our material for the summer months of the years 1946 and 1948 collected from littoral catches, in general corroborate the data in Table 16.

On the other hand, while conducting commercial operations far from the southern Crimean and northern Caucasian coastlines, mainly sprat was found in the stomachs of the dolphins which in June and July, as a rule, comprises 94-96% of the stomach contents. Freiman (1950) presents the same figure (96%) for sprat during the summer season. *118

TABLE 16

Food of the common dolphin during the summer-fall period. Number of food objects (in %) discovered in the stomachs of the animals based on the data for the years 1933-1934.[1]

Таблица 16

Питание белобочки в летне-осеннее время. Количество объектов питания (в %), обнаруженных в желудках животных, по данным 1933—1934 гг.[1]

1 Пункты	2 Июнь	3 Июль	4 Август	5 Сентябрь	6 Октябрь
7. Новороссийск	a Пел. иглы—98 b Хамса—2	a. Пел. иглы—38 b Хамса—32 c Шпрот—26 d. Ставрида—3 e Пикша—1	a Пел. иглы—86 b Хамса—7 d Ставрида—4 f Луфарь—3	a Пел. иглы—85 b Хамса—13 e Пикша—1 f Луфарь—1	a Пел. иглы—45 b Хамса—44 c Шпрот—10 e Пикша—1
8. Ялта	a. Пел. иглы—70 b Хамса—8 c Шпрот—13 g Идотея—4 e Пикша—3 f Луфарь—2	a. Пел. иглы—37 b Хамса—32 c Шпрот—12 g Идотея—9 e Пикша—9 f Луфарь—1	a Пел. иглы—57 b Хамса—32 c Шпрот—6 g Идотея—3 e Пикша—2	a. Пел. иглы—90 c Шпрот—9 g Идотея—1	a. Пел. иглы—85 g Идотея—1 e Пикша—8 h Барабуля—6

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[1] Батуми и Новый Афон не включены в табл. 16 за отсутствием материала из этих районов, ибо промысел у южного побережья Кавказа осуществлялся всегда только зимой и весной.

Key to Table 16:

1. Localties 2. June 3. July 4. August 5. September 6. October

7. Novorossiisk 8. Yalta a) Pelagian pipefish b) Anchovy c) Sprat

d) cavalla e) Haddock f) Bluefish g) Idothea h) Surmullet

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[1] Batumi and Novii Afon are not included in Table 16 due to the absence of material from these regions because the commercial operations are always carried out only in the winter and spring.

Thus, correlating these data, it can be considered that the principal food of the common dolphin in the Black Sea is the anchovy, pelagic pipefish and sprat, and that in the nutrition of the animals there are definite seasonal changes determined of course, not by the selective capabilities of the dolphin, but by the migrations and concentrations of the food stocks themselves.

Owing to the works of Puzanov (1923, 1936), A. I. Aleksandrov (1927) and Maiorova (1950) and others, it is well-known that the Black Sea anchovy spawns during the warm periods of the year and is dispersed at that time. In the fall their concentrations begin in the regions of Batumi, Poti, and Balaclava where, forming dense concentrations, they remain all winter. The Azov anchovy, also concentrating into large aggregations, leave the Azov Sea in the fall and over winter along the Caucasian coastline of the Black Sea, not coming down any farther south than Sukhumi, *119 according to S. M. Malyatskii (1949). In the spring they return to the Azov Sea where they spawn.

The sprat, in contrast to the anchovy, spawns all winter beginning in the fall. During this time the little fish remain dispersed throughout the entire pelagial zone of the Black Sea. In the summer, during the growing period, the sprat forms concentrations in the open sea.

Thus, it is precisely this fact which explains the seasonal changes in the principal food of the dolphin. In the winter, it is the stocks of anchovy and during the summer - the sprat. It appears that Freiman (1950) is undoubtedly correct when he explains the seasonal changes in the distribution of the dolphin precisely by this fact.

In light of the above, the footnote to p. 80 of Freiman's work (1950) is very surprising in which it is indicated that "the Black Sea expedition did not observe any concentrations of sprat in the Black Sea during the summer. There are no indications to this effect even in the literature".

While the first part of the footnote indicates only the incompleteness of the data of the expedition, the second part is astonishing. One can present a large list of works, including that of the editor of Freiman's work himself, where it is indicated that the sprat forms concentrations in the Black Sea during the summer. Finally, in the last report (1949) on the commercial fishes published by VNIRO (I.I. Kazanov - author), the following is written regarding the sprat: "Marine pelagic schooled (emphasis my own - S.K.) fish. Among the Black Sea fishes, comparatively cold-loving...Commercial activities: importance at the present time not very great due to the fact that the raw material is insufficiently utilized" (pp. 140-141).

It is evident from the presented data on the food of the common dolphin that it feeds on relatively small representatives of the pelagic fauna. Thus, one can summarize those major requirements which the principal food of the common dolphin must meet. These are:

1) pelagic way of life;
2) relatively small size of the individuals;
3) the formation of populations of dense concentrations.

While studying the nutrition of the Black Sea dolphin, I ran into the same phenomenon which I had noted earlier with respect to the beluga (1932); namely, the very large number of absolutely empty stomachs. This fact is noted by all of the authors who had the occasion to dissect the stomachs of small cetaceans.

Silant'ev (1903), Mal'm (1932), D. Gudger (1935), explain this fact by the exceptionally rapid digestion of the food. However, this version was not confirmed by direct experience, a fact that I have already mentioned (1936, 1940).

As it applies to the beluga, Arsen'ev (1939) explains this by the *120
fact that it feeds only on aggregated fish and that as a result, in the animals caught at times other than during the feeding period, a large number of empty stomachs are always observed.

Finally, this is explained by the wide prevalence of regurgitation of food during the catching operations which results in a large number of empty stomachs. Nevertheless, we succeeded in establishing some fluctuations in the number of empty stomachs which allow these fluctuations to be used as a certain index in the nature of feeding in the animals.

Data for the year 1935 in the Batumi region (Fig. 26) quite definitely shows an inverse relationship between the shape of the curve reflecting the number of stomachs containing anchovy and the number of empty stomachs. During the latter half of May, the anchovy disappeared completely and the number of empty stomachs reached 100%. After this, the commercial operations were discontinued due to the departure of the dolphin from this region. A similar relationship was observed by me in the Yalta region.

We were unsuccessful in observing any qualitative or quantitative fluctuations in the food during the various times of day (with the exception that during the morning catches the food was more diverse than in the day catches), but the number of empty stomachs even here appeared as a certain indicator.

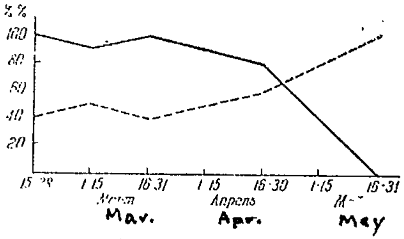

Рис. 26. Соотношение количества желудков, содержащих хамсу (сплошная линия), и количества пустых желудков (пунктирная линия) в районе Батуми с февраля по май 1934 г.

Fig. 26. Ratio of the number of stomachs containing anchovy (solid line) and the number of empty stomachs (dotted line) in the Batumi region from February to May, 1934.

As we can see, the curves run almost parallel to each other from which we can conclude that the fluctuations in the number of empty stomachs during the various months in the morning and day catches are produced by the same causes. Still, *121 the "day" curve is always higher than the "morning" curve.

If one were to select the days in which both morning and day catches were conducted and count the empty stomachs (see Table 27), then having compared the data of Fig. 27 and Table 17, it is easy to become convinced that the morning is, apparently, the time of more intensive "gorging" than during the day.

The number of empty stomachs provides some material for opinions regarding the intensity of feeding by the various sex and age groups of animals.

Three age groups of males and females according to linear measurement (Table 18) can be established for the Black Sea common dolphin. Having counted the empty stomachs in every one of these groups, we will obtain a picture represented in Fig. 28.

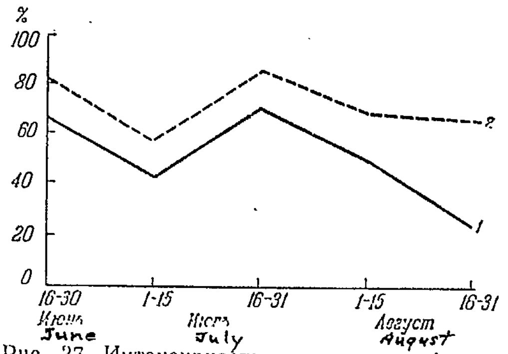

Рис. 27. Интенсивность питания дельфинов в различное время суток в районе Ялты (июнь — август 1934 г.):

1 — процент пустых желудков в утренних уловах;
2 — то же в дневных уловах.

Fig. 27. Intensity of feeding of the dolphin during the various times of day in the Yalta region (June - August, 1934).
1) % of empty stomachs in morning catches
2) % of empty stomachs in day catches.

*122 These data allow one to conclude the following:

1) there are no sex differences in the intensity of feeding;

2) the young, sexually immature animals feed less intensely than the adult ones:

3) during the first half of August, the sexually mature males and females feed considerably more intensely than the remaining age groups.

As will be apparent from later discussions, the height of the mating season in the common dolphin is in July. During this time, the animals feed very little and lose weight sharply. After the height of the mating season, the emaciated sexually mature animals begin to feed intensely which decreases the number of empty stomachs found in them during the first half of August.

Table 17

Number of empty stomachs (in %) in morning and day catches

Таблица 17

Количество пустых желудков (в %) в утренних и дневных уловах

1 Дата	2 Утренние уловы	3 Дневные уловы
20/VI	54	80
24/VI	80	96
26/VI	71	97
27/VI	67	71
8/VII	38	81
24/VIII	25	37
13/X	60	76

Key to Table 17:

1) Date 2) Morning catches 3) Day Catches.

Table 18

Approximate lengths of the various age groups

Таблица 18

Примерные размеры различных возрастных групп

1 Пол	2 Длина (в см)	3 Возрастная группа
a Самцы	120—150	c Неполовозрелая
b Самки		
a Самцы	151—170	d Переходная
b Самки	151—160	
a Самцы	171—200	e Половозрелая
b Самки	161—200	

Key to Table 18:

1) Sex 2) Length (in cm) 3) Age group a) Males b) Females

c) Sexually immature d) Transitional e) Sexually mature.

Figure 28

Seasonal changes in the intensity of feeding of the various age and sex groups of dolphins in the Yalta region (June to August, 1934).

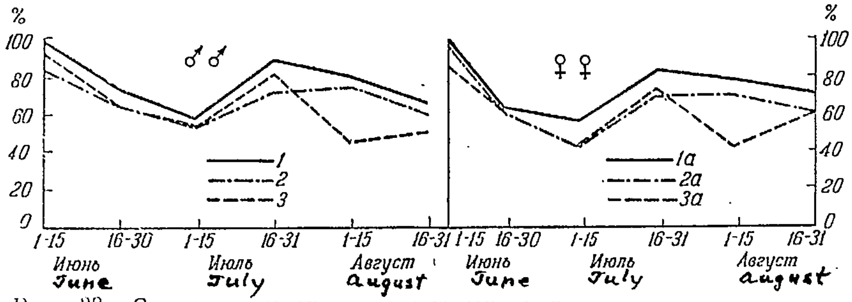

Рис. 28. Сезонные изменения в интенсивности питания различных возрастных и половых групп дельфинов в районе Ялты (июнь — август 1934 г.):

1 — самцы размером 120—150 см; 1-а — самки размером 120—150 см; 2 — самцы размером 151—170 см; 2-а — самки размером 151—160 см; 3 — самцы размером 171—200 см; 3-а — самки размером 161—200 см.

Цифры слева и справа—процент пустых желудков.

Key to Fig. 28:

1) Males with a length of 120-15- cm; 1a) Females with a length of 120-150 cm; 2) Males, 151-170 cm; 2a) Females, 151-160 cm; 3) Males, 171-200 cm; 3a) Females with a length of 161-200 cm.

Figures on the left and right - percent of empty stomachs.

Using this index, it is possible to trace the influence of the biological condition of the females on the intensity of feeding.

Figure 29

Intensity of feeding in female dolphin in the Yalta region (June-August, 1934) in relation to their biological condition.

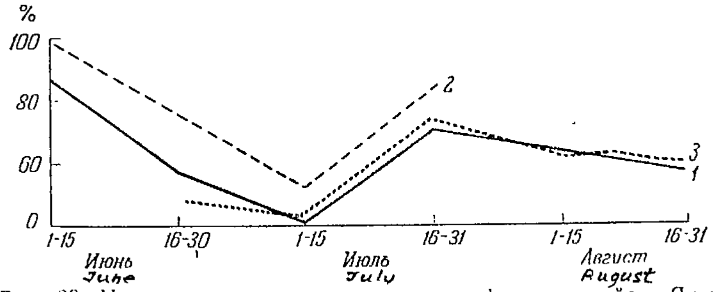

Рис. 29. Интенсивность питания самок дельфина в районе Ялты (июнь — август 1934 г.) в зависимости от их биологического состояния:

1 — яловые самки; 2 — беременные; 3 — кормящие.
Цифры слева — процент пустых желудков.

Key to Fig. 29:

1. Barren females 2. pregnant females 3. suckling females

Figures on the left - percentage of empty stomachs

From Fig. 29, on which the number of empty stomachs in barren, pregnant and lactating females is shown, it is quite distinctly evident that in barren and lactating females this number is always the same while in the pregnant ones, it is invariably greater. Consequently, pregnant females do not feed as intensely as the lactating and barren females who feed with equal intensity.

This is explained by the fact that on Fig. 29 only the summer months are presented corresponding to the last stage of pregnancy. During this time, the pregnant females are considerably heavier and consequently less mobile than the barren and suckling females. The intensity of feeding of a dolphin, on the other hand, due to its pelagic character, is determined to a greater degree by the maneuverability of the animal.

Concluding the review on nutrition in the common dolphin and turning *123 to an examination of nutrition in the remaining Black Sea dolphin, one should mention first of all the considerably smaller amount of material on the nutrition of these dolphin in comparison with that on the common dolphin.

Data by foreign authors on nutrition of the harbour porpoise, just as on the common dolphin, are general and incomplete. The majority of authors consider the principal food of this dolphin to be the shad and mackerel; some add sardine, sprat and also crustaceans and molluscs. Millais (1906) supplements this list with trout, eel and cod, and Freund (1932); with crustaceans (Decapoda) and cephalopod molluscs (Cephalopoda). Eschrict (1849) found marine algae in the stomachs of harbour porpoises as well.

Birulya (1933, 1934) points out that in the Barents Sea this dolphin feeds on herring, capelin sand lance, and in the White Sea on <u>Eliginus navaga.</u>[1] Chapskii (1941) names the same fish for the Murman Coast, considering it possible to add molluscs and crustaceans to the list.

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[1] Trans. note: Since the author fails to give the Latin name I have gone by Ricker who gives "any species of <u>Eleginus</u>"for <u>navaga</u> (p. 151).

In the Black Sea, according to Meier's data (1794), the porpoise feeds on mackerel.

In subsequent works by Danilevskii (1871), Silant'ev (1903), Dinnik (1910), Puzanov (1923, 1936), Mal'm (1932, 1933) and Kravchenko (1932), the principal and only food of this dolphin is indicated as anchovy.

In March and April of 1934 in the Batumi region, analyzing the contents of 21 stomachs of this dolphin, I reckoned that all of that material constituted the remains of only anchovy. Taking into consideration these data, and the data from the literature, I came to an incorrect conclusion regarding the pelagic nature of feeding in this dolphin (S. E. Kleinenberg, 1936).

The inaccuracy of the position expressed by me was demonstrated by *124 Tsalkin (1940). He dissected about 4000 specimens of the harbour porpoise mainly in the Sea of Azov and the Kerch Strait. On the basis of this extremely reliable material, Tsalkin (1940, p. 162) gives the following list of food objects:[2]

" 'monkey goby' - Gobius melanostomus Pall.
rotan goby - G. rotan Nordm.
Mushroom goby - G. cephalarges Pall.
syrnam goby - G. syrnam Nordm.
toad goby - Mesogobius batrachocephalus Pall.
Black Sea flounder - Pleuronectes flesus luscus Pall.
Black Sea sole - Solea nasuta Pall.

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[2] Trans. note: Since the author provides the Latin names, I have again gone according to Ricker and given as close a common name as possible for the above fish. Even in Ricker, the Latin names provided by the author and those given by Ricker in many instances do not match up.

Black Sea anchovy - Engraulis enscrasicholus L.

Sand smelt - Atherina pontica Eichwald

Pike-perch - Lucioperca lucioperca L.

Bream - Abramis brama L.

Mullet - Mugil auratus Risso.

Black Sea whiting - Gadus euxinus Nordm.

Shad - Caspialosa sp.?"

Besides the indicated fishes, Tsalkin also found four species of crustaceans, eight species of molluscs and one specie of marine algae in the stomachs of this dolphin. The latter occurred only in a negligible number of individuals. "Thus," writes Tsalkin (1940), "not only the basic, but almost exclusive food of the harbour porpoise in the Azov and Black Seas are various species of fish" (p. 163). In other words, this means that implied here is a basically benthonic nature of feeding in this dolphin.

The quantitive character of nutrition showed that of the enumerated fishes, the principal food of the harbour porpoise is the "monkey goby", the rotan goby, anchovy and the sand smelt. The first two species are the most important. The dolphin begins to feed on the anchovy and sand smelt only in the spring and in the fall, i.e. when these fish form large concentrations. The rest of the time the dolphin feeds aslmost exclusively on goby.

Fifty stomachs of dolphin caught in the Anapa region in April of 1949 which I analyzed gave a picture similar to that obtained in Batumi in 1949. All of the stomachs contained anchovy exclusively.

Summarizing the above, it can be noted that according to the materials from the years 1934 and 1949, one gets the impression that in the Black Sea, the dolphin, forced to change its usual benthonic nature of feeding, changes to pelagic food.

If one takes into consideration the presence of great depths even in the littoral zone of the Black Sea, and the fact that it is much more difficult for the animals to acquire benthonic food here than in the shallow waters of the Sea of Azov, then it is entirely possible to assume that it is precisely these reasons which condition the change in the nature of feeding in this dolphin in the Black Sea as compared with the Sea of Azov.

We will also mention yet another fact important for further exposition which consists in the fact that the objects of feeding in this dolphin are distributed mainly throughout the littoral zone.

There is even less information in the foreign literature regarding the nutrition of the third of our dolphins - the bottlenose - outside of the Black Sea. It is restricted to a laconic assertion by the majority of authors that this animal feeds on fish. Fischer (1881) presents somewhat more detailed data who found fish bones and entire eels and cuttlefish in the stomachs of bottlenoses. P. van-Beneden (1889) reports similar information. Scott and Lord (1920) give some data on the nutrition of the bottlenose near the Australian and Tasmanian coasts, but without any details. McBride (1940) notes that near the Florida coast, the favorite food of this dolphin are mugiloid fishes.

Kravchenko (1932) studying nutrition in the bottlenose in the Black Sea, wrote that it hunts schools of fish only at night. Mal'm (1932, 1933) noted that its favorite food in the Black Sea is the Black Sea shad and grey mullet.

A very insignificant amount of material collected in 1933 allowed me to publish in 1936 only a list of food objects of the bottlenose. Material from the years 1934 and 1937 gave more detailed information reported by me in 1938. As a supplement, I analyzed material from 50 animals in 1948 in Yalta.

Summarizing all of this material, I obtained the following list of food objects of the bottlenose:

Black Sea whiting - Odontogadus merlangus euxinus (Nordm.);
Flouder - Bothus maeoticus Pall.;
Thornback ray - Raja clavata L.;
Croakers - Sciaena cirrhosa L.;
Scorpionfish - Scorpaena porcus L.;
Black Sea anchovy - Engraulis encrasicholus (L.);
Surmullet - Mullus barbatus ponticus Essipov;
Mullet - Mugil sp.?;
Striped mullet[1] - Mugil cephalus L.;
Bonito - Sarda sarda (Bloch.).

Besides fish, shrimp (Crangon crangon L.) and marine cockroach (Idothea algirica Lucas) also occurred in the stomachs of the bottlenose.

Often sand, pebbles and the following molluscs were discovered in the stomachs of the bottlenose: *126

Nassa reticulata L., Cardium sp.?
Modiola phaseolina Phillipi, Syndesmya sp.?
Cardium simile Milaschewitsch, Mytilus sp.?

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[1] The striped mullet was not disclosed in our material. It was included in the list on the basis of data in the literature and corroborations of commercial dolphin fishermen.

Judging by the presence of sand and pebbles in the stomachs of the bottlenose, it can be assumed that the molluscs are seized by the dolphin accidentally together with the soil during feeding on one or another bottom object but that they do not themselves consitute the food of the animals. It is entirely probable also that the marine cockroach as well enters the stomach of the bottlenose accidentally together with the gut of the fish it eats, but that it does not itself constitute the food of the dolphin.

In any case, it is possible to definitely consider that this dolphin as were the two preceding species, is a typical ichthyophage, as well.

Table 19

Nutrition of the bottlenose in the Yalta region

Таблица 19

Питание афалины в районе Ялты

1 Месяц и год	2 Количество проанализированных желудков	3 Количество кормовых объектов (в %)	1 Ме год	2 Количество проанализированных желудков	3 Количество кормовых объектов (в %)
4 Февраль 1934	2	a Пикша — 60 b Камбала — 30 c Идотея — 10	8 Июнь 1934	24	a Пикша — 90 b Камбала — 6 f Скат — 2 c Идотея — 2
5 Март 1934	26	d Хамса — 100	9		
6 Апрель 1934	82	d Хамса — 52 a Пикша — 30 b Камбала — 10 e Умбрина — 6 f Скат — 2	Июль 1933	16	a Пикша — 60 b Камбала — 17 h Креветка — 8 j Кефаль — 3 k Барабуля — 3 c Идотея — 3
7 Май 1934	21	a Пикша — 84 b Камбала — 14 e Умбрина — 1 f Скат } 1 g Скорпена } 1 h Креветка } 1	9 Июль 1934	9	a Пикша — 93 b Камбала — 2 e Умбрина — 2 f Скат — 1 c Идотея — 2
7 Май 1948	50	a Пикша — 93 g Скорпена — 4 f Скат — 2 i Пеламида — 1	10 Октябрь 1937	2	k Барабуля — 80 a Пикша — 14 h Креветка — 4 c Идотея — 2

Key to Table 19:

1) Month and Year 2) Number of analyzed stomachs 3) Number of food objects (in %) 4) February 5) March 6) April 7) May 8) June 9) July 10) October

a) Black Sea whiting b) flounder c) Idothea d) anchovy e) croakers f) thornback ray g) scorpionfish h) shrimp i) bonito j) grey mullet k) surmullet

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In order to form an opinion on the significance of the indicated food objects of the bottlenose I present Table 19, from the data of which *127 it is evident that in the stomachs of the dolphin, Black Sea whiting occurs most often, followed by the flounder. The remaining fishes are of secondary importance.

Despite the clear benthonic nature of the feeding of the bottlenose, it feeds intensely on anchovy alone during periods of concentrations of this fish. This, in the spring of 1934, when large concentrations of anchovy were observed in the region of the southern Crimean coast, only anchovy were found in the stomachs of the bottlenose caught in the Yalta region. It predominates in April as well. From May through October, the food of the bottlenose was more diverse, but Black Sea whiting was of major significance.

As a result, it can be concluded that the bottlenose, similar to the Azov dolphin, alters its usual benthonic character of feeding only with the presence of dense concentrations of anchovy in the region of its habitation. In other words, regardless of the nature of feeding of the animals, anchovy, during the formation of its concentrations, is of paramount importance in the nutrition of all three species of Black Sea dolphin, and in this way, determines the seasonal change in the food. According to a graphic description by Puzanov (1923), during the migration of anchovy "countless schools of petrel (Puffinus) soared through the air and the sea teemed with dolphins both local (*Delphinus*, less commonly *Tursiops*) as well as the "Azov" (*Phocaena*) which always accompany the anchovy" (p. 122).

Thus, in spite of the clearly benthonic nature of feeding, in the bottlenose, it can - while it is true that only for a certain period of time during the year - nevertheless be included in the scheme of food relationships of organisms in the Black Sea pelagial zone constructed by V. N. Nikitin (1948).

In contrast to the preceding dolphins, the bottlenose feeds not only on small but large fishes as well. At times, the stomach was flat and round resembling a plate. Upon dissection, intact, slightly digested flounder and thornback ray were found in it. It is well-known that the skin of the latter is equipped with relatively long, very sharp and curved spines (in some of the stomachs of bottlenose, up to 28 such spines were found). The skin of the flounder also bears spines; granted, not as sharp and as long. How a bottlenose can swallow such objects without injuring its mouth, throat and esophagus, is beyond comprehension.

There was an opinion circulated in the literature (Kravchenko, 1932; Mal'm 1932, 1933) that the bottlenose feeds exclusively at night. The fact that in a catch of bottlenose conducted on June 12, 1933 at 10:00 o'clock in the morning, in my presence, only slightly digested (i.e. just recently consumed) food was found in the stomachs of the animals, was given as corrorboration for this artificial conclusion. It is only necessary *128 to note that the food of the bottlenose, just as the food of the harbour porpoise, is distributed throughout the pelagic zone.

Having analyzed the nutrition of all of the Azov-Black Sea dolphin, the following general conclusions can be formulated:

1) All of the three species of dolphin are typical ichthyophagi.

2) The common dolphin feeds exclusively on pelagic fauna. The feeding habits of the harbour porpoise and the bottlenose indicate basically a benthonic nature; the harbour porpoise, in contrast to the bottlenose acquiring benthonic food only in the shoal waters.

3) The food supply of the common dolphin is distributed both throughout the littoral zone and in the open sea, while the basic food supply of the other two dolphin is confined to the littoral zone.

4) The permanent food objects of the harbour porpoise and the bottlenose are always found widely dispersed in the sea never forming large schools. The common dolphin devours mainly aggregated fishes.

5) In contrast to the other dolphins, the bottlenose eats not only small, but large fish as well.

The conclusions formulated here are very important for further exposition, since they determine to a considerable degree the differences in the population numbers of the individual species in the basin, their pattern of dispersion and distribution, behavioral features, and also the morphological and physiological characteristics of the various species.

In attempting to clarify a question that interest us - how much fish does a dolphin outside of captivity eat in a day - I note with regret that no such data are available. The thing is that the food supply and the quantity of its components are usually determined by the otoliths or by the characteristic bones of fish remaining in the stomach. Nevertheless, the length of time such food remains in the stomach, i.e. after what period of time the otoliths are emptied from the stomach, is unknown. Therefore, when the food is well digested, the researcher often does not know what he is dealing with: the remains of a single feeding, that of an entire day's, or that ingested over a period of days? Moreover, the issue of how often a dolphin feeds during the course of the day also does not lend itself to determination.

R. Woltereck (1936) considers, more on the basis of speculation than on factual data, that a single common dolphin destroys about 10 kg of fish a day.

There is more specific information available regarding the nutrition of bottlenoses in captivity. Thus, in the New York basin, according to the data of Townsend (1916) and St (1916), adult bottlenoses consume 32 kg of fish a day. In the Florida Oceanarium, according to McBride's data (1940), they consume 20 kg of fish each.

Judging by photographs by the latter, from which it is clear how a bottlenose, leaping out of the water, takes a fish practically out of the hands of a person, one can conclude that this allowance does not sufficiently satisfy the animals. *129

Taking into consideration these data and the smaller size of the common dolphin, which is made up for by its greater mobility, one can assume that the figure reported by Woltereck (1936) is not exaggerated.

Turning to the dynamics of fatness, it is first necessary to mention that the material which I have at my disposal pertains almost entirely to the common dolphin. The very insignificant amount of material on the bottlenose and the absence of any knid of material on the harbour porpoise compels me to examine this issue on the basis of the common dolphin, especially as the data in the literature pertain wholly to the common dolphin.

The term dynamics of fatness I take as the seasonal change in the amount of subcutaneous fat layer, disregarding completely the issue of general fatness of the organism of the animal. Seasonal changes in the amount of subcutaneous fat in the dolphin are well known. The first attempt to express these changes in figures belongs to Mal'm (1932), according to whose data the amount of fat in an average-sized dolphin weighing 64-72 kg during the summer months is equal to 20 kg on the average, increasing almost twofold during the winter months.

Maiorova and Danilèvskii (1934), the authors of the original, and the first work according to detailed research, come to the conclusion that the dolphin has the greatest amount of fat during February and March. Beginning in May, the thickness of the fat layer and the mean weight of the fat on the skin decreased simultaneously. The dolphin is leanest at the end of the summer and in the fall.

In discussing fatness, they operate only with absolute figures, i.e. with the mean weight of the fat on the skin and the mean thickness of the fat layer. Moreover, fatness is a relative concept. Taking into consideration the differences in sizes of the animals that are caught, it is clear that both of the indicated values depend not only on fatness, but on the size of the animal as well. Due to this purely methodological inaccuracy, one of the authors' conclusions turned out to be incorrect. Thus, on the basis of vast amterial, they show that dolphins acquired by means of shooting operations are on the average smaller than those caught with seine nets. Further, demonstrating that the mean weight and mean thickness of the fat layer in the dolphin acquired by shooting operations are smaller than those of seine net operations, the authors write: "Thus, shootimg operations utilized dolphin not only of smaller dimensions, but of a lower fatness than those of seine net catches" (p. 186).

Later on I will attempt to demonstrate that this statement is not in accordance with fact. Its invalidity results directly from the methodology of the procedures. It is entirely natural that in dolphins of smaller dimensions and weight, the thickness of the layer of blubber will also be smaller than in larger animals. However, this does not as yet in the least demonstrate that dolphins of smaller dimensions have a lower fatness. Here, a completely opposite result can be observed for fatness is a relative concept and in discussing it, it is impossible to operate with absolute figures. *130

Figure 30

Fatness dynamics in the dolphin in the Yalta region. Figures on the left - coefficient of fatness.

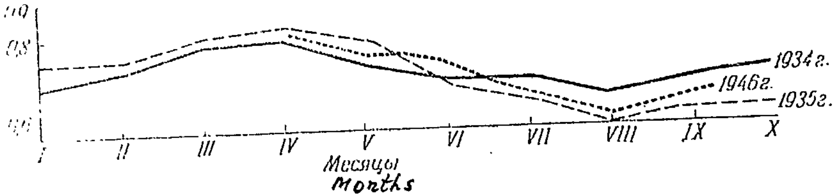

Рис. 30. Динамика упитанности дельфина в районе Ялты. Цифры слева — коэффициент упитанности.

Mal'm and N. P. Tatarinov (1936) also came to similar conclusions with regards to the periods of decrease and increase in the amount of fat in the dolphins. Finally, data published by me (1940) basically support the conclusions of the preceding authors.

For the characteristic of fatness in the animals, I used a value (the ratio of the weight of the blubber to the weight of the carcass) which I called the coefficient of fatness. The seasonal changes of this value in the common dolphin for various years and in the various regions are presented in Figs. 30 and 31.

Summarizing the data of these Figures, it is easy to establish that the general directions of the trend of the curves during the various years and in the various regions are similar. From this conclusion, it follows that the dynamics of fatness in dolphins in the various years and in the various regions follow the same trend, i.e. that the decrease and increase in the amount of fat in the dolphin is a systematic process which repeats itself in the same manner from year to year regardless of the region of habitation of the animal.

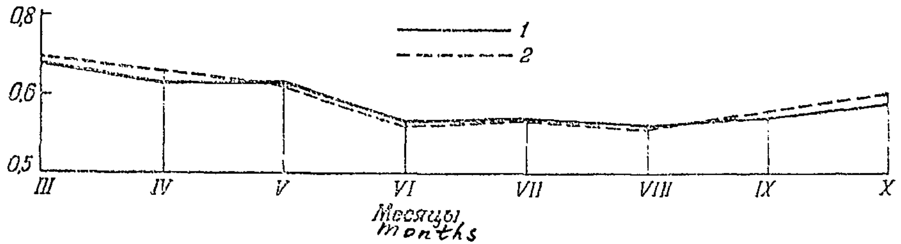

Рис. 32. Динамика упитанности дельфинов, добытых неводным и бойным промыслом в районе Новороссийска (март — октябрь 1934 г.).

Цифры слева — коэффициент упитанности.

1 — неводной лов; 2 — бойный (стрельбный) промысел.

Figure 32. Dynamics of fatness in dolphins acquired by seine net and shooting operations in the Novorossiisk region (March-October, 1934).

Figures on the left - coefficient of fatness.

Key to Fig. 32:

1) seine net operations 2) shooting operations a) Months

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[1] Trans. note: See p. 199a for Figure 31.

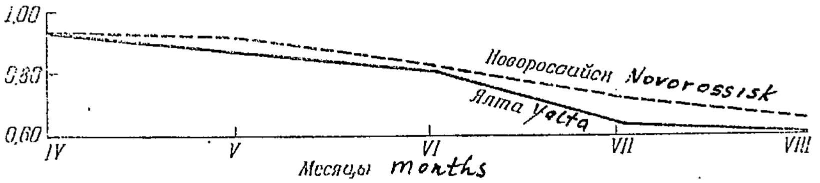

Рис. 31. Динамика упитанности дельфина в районах Ялты и Новороссийска (апрель — август 1934 г.).
Цифры слева — коэффициент упитанности.

Fig. 31. Dynamics of fatness in dolphin in the Yalta and Novorossiisk regions (April-August, 1934). Figures on the left - coefficient of fatness.

Maximum fatness in the dolphin is in March-April (Maiorova and Danilevskii, 1934); Tomilin (147) adds April as well (our materials do not allow us to do that). The minimum is in August.

It should also be noted that fatness in the animals decreases at a faster rate (May, June, July, August) than it increases (September, October, November, December, January, February).

The changes in the coefficient of fatness in dolphins acquired by shooting operations and seine net operations for the period March to October are represented in Fig. 32. These data show with perfect obviousness in contrast to the assertion of Maiorova and Danilevskii (1934) that fatness in dolphins acquired by both modes of operations are completely identical.

I did not find any differences in either the dynamics of fatness or in fatness itself in relation to the sex of the animal.

Unfortunately, I was unable to take advantage of the weight data for determining fatness of the various age groups. Here, I was compelled to confine myself to measurements of the thickness of the fat layer. Therefore, I characterize fatness of the various size groups by the ratio of the fat layer to the length of the animal.

These data for the various size groups, with intervals of 10 cm for the period March to August are presented in Fig. 33.

As is evident, this ratio in the smaller animals is expressed by a larger value, and with an increase in the size of the animal, the ratio of the thickness of the fat layer to the length of the animal decreases. As a result, animals with smaller dimensions have (relative to their length) *132 a greater amount of fat than larger animals, i.e. fatness in small dolphins is higher than in larger ones, and with an increase in size of the animal fatness decreases. Gray (1928) came to the same conclusion as regards the whale.

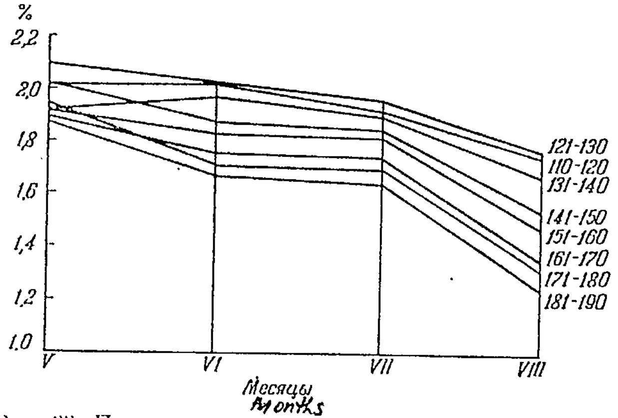

Рис. 33. Процентное отношение толщины жирового слоя к длине животных у различных размерных групп дельфинов в районе Ялты (май — август 1934 г.).

Цифры слева — отношение толщины жирового слоя к длине животного (в %); справа — размеры животных (в см).

Figure 33. Percentage ratio of the thickness of the fat layer to the length of the animals in the various size groups of dolphin in the Yalta region (May-August, 1934). Figures on the left - ratio of the fat layer thickness to the length of the animal (in %); on the right - size of animals (in cm).

According to the character of the shape of the curves in Fig. 33, three quite specific groups are noted: 110-140, 141-160, and 161-190 cm. The immature, transitional and adult groups lie approximately within these lineal boundaries, as was indicated earlier (see feeding of the common dolphin). Consequently, the dynamics of fatness is connected with the maturation of the gonads, the sexually immature animals losing weight more gradually and to a considerably lesser degree than the sexually mature ones which lose weight particularly sharply during the period July to August (the height of the mating season of this dolphin falls in July).

The thickness of the fat layer in females with a length of 160-190 cm for the period May to August is shown in Fig. 34, from which it is clear that throughout this entire period it is practically identical both in the barren as well as the pregnant and suckling females. The direction of the shape of the curves is also similar. Thus, not only the rates of weight loss, but fatness in the barren, pregnant and lactating females is identical as well.

Having analyzed the material on the dynamics of fatness in the dolphins, it is possible in summing up to formulate some basic conclusions.

1) A quite distinct pattern in the dynamics of fatness in the dolphins is observed: period of maximum fatness being March-April; minimum -- August. *133

2) The dynamics of fatness in dolphins is a process proceeding from year to year and in various regions of habitation in a general direction identically.

3) Animals of smaller dimensions have a higher fatness, their fatness decreases with an increase in size.

4) Changes in fatness are observed not only in adult, sexually mature animals, but also in the young sexually immature ones as well. However, in the latter the amount of fat decreases more gradually and to a lesser degree.

5) Differences between the females and males in fatness and in the

rates of decrease in the amount of fat are not observed.

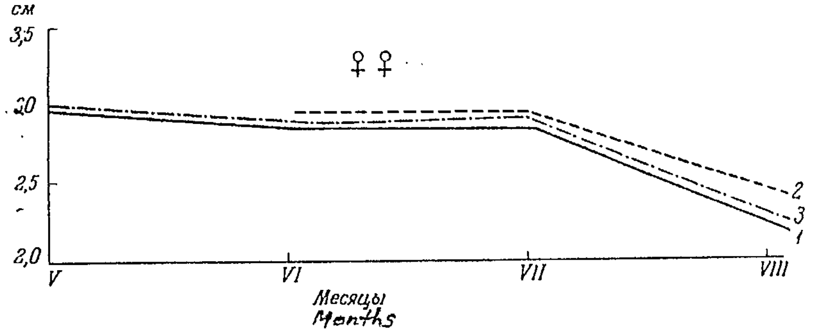

Рис. 34. Толщина (в см) жирового слоя самок дельфина в районе Ялты (май — август 1934 г.) в зависимости от их биологического состояния.

1 — яловые самки; *2* — беременные; *3* — кормящие.

Figure 34. Thickness (in cm) of the fat layer in female dolphin in the region of Yalta (May-August, 1934) depending on their biological condition.

Key to Fig. 34:

1) Barren females; 2) Pregnant; 3) Nursing a) Months

Barrenness, lactation and pregnancy in the females do not affect their weight loss or their fatness either.

The causes of the dynamics of fatness in dolphins according to Mal'm (1932) are explained by the decline in feeding during the summer-autumn period, the rise in water temperature and the reproductive cycle (mating).

It is without doubt that these causes affect the summer decrease in the amount of fat in the dolphins; however, it appears that their effect is not manifested in equal degree.

It is clear that the reproductive cycle is not the primary cause since the summer decrease in the amount of fat is also observed in the young, sexually immature animals.

Feeding conditions during the summer are not the same; nevertheless, these fluctuations in no way affect the dynamics of fatness. Moreover, periods of weight loss and the increase in the amount of fat do not correspond to the change in the feeding conditions (the concentration of anchovy, for *134 example, begin in October, while the fatness condition in dolphins already begins to rise in September). Consequently, feeding is not the primary reason for the dynamics of their fatness either.

Let us examine changes in water temperature. Judging by N. M. Knipowitsch's data (1925, 1932) and those of other authors, the minimum temperature of the surface layers of the Black Sea set in February-March (period of maximum fatness in dolphins). Beginning in April, the temperature of the water rises and reaches a maximum in July-August (period of minimum fatness in the dolphins). Beginning in September, the temperature of the water falls, Thus, if we plot the temperature of the surface layers of the Black Sea on our Fig. 30 where the curves show the dynamics of fatness in the dolphins, then an inverse relationship between them appears: the higher the temperature of the water, the lower the fatness of the animal, and conversely; the lower the temperature of the water, the higher the fatness. It stands to reason that a rise in the temperature of the water should show up in the fatness of all of the age groups. As was demonstrated, the summer weight loss occurs in all of the age groups. So it can be assumed that it is the change in the temperature of the water which is the primary cause of the dynamics of fatness in the animals. It appears only that the summer weight loss in the animals occurs not at all as a result of "an increase in metabolism" advanced by Mal'm (1932, p. 5); for the dolphin is an animal with a constant body temperature. The fat layer in the dolphin, as in all cetaceans, is, apart from everything else, a thermoregulatory organ. Owing to this, a rise in the temperature of the water could not have an effect on the amount of fat, however, this effect by itself is not sufficient.

It should not be assumed however, that feeding and the reproductive cycle do not in any way affect the fatness of the animals. It is clear that an increase in the fatness from the winter months towards March-April is caused by better feeding by the animals during winter (an abundance of anchovy concentrations). It is also clear that it is precisely the reproductive cycle that intensifies the weight loss in sexually mature animals as compared with the sexually immature ones.

Thus, it can be concluded that not one, but several causes affect the dynamics of fatness, of which, apparently, the changes in the water temperature are of basic importance.

In order to speak more confidently of the reasons determining the dynamics of fatness, it is necessary to understand the mechanism of this phenomenon, i.e. to study the physiological processes which occur in the organism of the animal. Therefore, in future studies, it is necesssary to conduct experiments on the changes in the intensity of the oxidizing and lipo- *135 lytic processes in the organism of the dolphin simultaneously with observations on fatness which I, unfortunately was not in a position to do so.

As was already mentioned earlier, it was not possible to collect material on the dynamics of fatness in the other Black Sea dolphins due to the limited period of commercial activity involving these dolphin. At the same time, it would have been interesting to compare at least the fatness of the various species. Therefore, I used data from the commercial catches for the years 1948 and 1949 from the Yalta and Anapa regions. In these data there are extremely important figures capable of throwing light on the issue touched upon: number of head of animals, their total weight and the weight of the khorovin (blubber with the skin).

On the basis of these data for April and May (when all of the species were being caught), I compiled Table 20 below which reflects, as a result, the period of high fatness in the dolphins.

Table 20

Fatness in dolphins of the Black and Azov Seas

Таблица 20

Упитанность дельфинов Черного и Азовского морей

1 Виды	2. Средний общий вес одного животного (в кг)	3 Средний вес подкожного жира (в кг)	4 Количество жира, приходящегося на 1 кг общего веса животного (в г)
5. Афалина	119,0	35,7	300,0
6. Белобочка	53,0	19,4	366,0
7. Азовка	31,0	12,6	406,5

Key to Table 20:

1) Species 2) Mean total weight of a single animal (in kg)

3) Mean wt. of subcutaneous fat

4) Amount of fat per 1 kg of total weight of the animal (in g)

5) Bottle-nose dolphin 6) Common dolphin 7) Harbour porpoise

That inverse relationship between fatness and the size of the animal which I established within one species on the basis of the common dolphin, is distinctly evident in the Table within the various species as well.

Such a regularity can be considered as evidence for the fact that the subcutaneous layer of fat is, apart from everything else, a thermoregulatory organ. It is well-known that the smaller the area of the body, the greater is its heat loss. As a result, the smaller the body, the more the relative amount of fat that it must have. It is precisely this fact that can explain that inverse dependency of fatness on body size which was established by us, both within a single species and among various species of dolphin, and which Gray (1928) also noted for whales.

In absolute figures, as is evident from Table 20, the bottlenose gives almost twice as much blubber as the common dolphin, and almost three times more than the harbour porpoise.

3. DISTRIBUTION

The distribution of the individual species of dolphin within the Azov-Black Sea basin has its own specifity conditioned by the feeding habits of the animals. *136

First of all, let us note that the common dolphin and the bottlenose are specific only to the Black Sea and do not inhabit the Sea of Azov. The Azov and the Kerch Strait, although it occurs in the Black Sea as well.

Let us examine the distribution of the common dolphin.

B. Poznanskii (1880), Silant'ev (1903), Kravchenko (1932) and Mal'm (1932) consider that the common dolphin is distributed exclusively throughout the littoral zone and do not venture out into the open sea.

On the basis of the study of feeding [the presence of such objects as the pelagic pipefish (*Syngnathus schmiditi*) and the marine cockroach (*Idothea algirica*] I porposed an hypothesis (1936) that this dolphin has to occur in the open sea as well.

Zernov (1913a), introducing Syngnathus schmiditi to the description of this species by A. M. Popov (1927) under the name Syngnathus phlegon Risso pointed out that of all the Syngnathidae, a pelagic way of life is peculiar only to this species. B. S. Il'in (1933) quite confidently relegates this pipefish to a typical representative of the halistatic biocoenosis.

As regards the marine cockroach, or Idothea, there were disagreements in the literature. Thus, for example, Sovinskii (1894) pointed to the small distribution of this species in the Black Sea and denied its pelagic way of life. Later, Zernov (1913a) characterized this species as an extremely common characteristic passive-pelagic form of the open sea. And finally, Il'in (1933), considering the Idothea an active-pelagic form, also relegates it to a typical representative of the halistatic biocoenosis.

That the Idothea is widely distributed in the Black Sea, one can judge from the fact that it occurs in the stomachs of dolphin from all regions where our observations were conducted.

The feeding of common dolphin on this object characteristic of the open sea regions confirms that this dolphin is by no means distributed only throughout the littoral zone.

In 1936, the Azov-Black Sea Institute of Fisheries and Oceanography (Kerch) began a regular aerial reconnaissance of marine animals and fishes in the eastern half of the Black Sea. Its tasks, organization, procedural methods and the first results as regards this dolphin were set out by Tsalkin (1937, 1937a, 1938a) who supervised it in its initial period. *137

The activities of the aerial reconnaissance, having enormous significance in the development of the commercial whaling operations of the

Black Sea dolphin, not only confirmed the conclusion presented above, but in addition to that, gave irrefutable and abundant data which will make it possible to clarify the nature of the distribution of the common dolphin in the Black Sea.

Of the works, throwing light on the results of the aerial reconnaissance operations, the most interesting to us is Tsalkin's last work (1938a) whose value lies in the fact that it not only throws light on the summer-fall dispersion of the dolphin in the eastern part of the Black Sea, but at the same time provides an analysis of the stomach contents of the animals from the concentrations that were discovered. Due to this, it is possible to conjecture on what type of food one or another aggregation of dolphins was concentrated on.

Using a plane made it possible for Tsalkin to inspect about 150,000 km^2, which comprises more than one third the area of the Black Sea.

Over this area, the dolphins were encountered in schools of various numbers and concentrations. Small dispersed schools were encountered. Encountered as well were very large schools consisting of 250-300 head in each one. When in an area of about 500 square miles up to 1000 such schools were concentrated, the total numbers of dolphin in such a concentration consisted of up to 2500-3000 head per square mile. The dolphins did not keep together uniformly in such concentrations but in "patches". The number of dolphin in such patches per square mile, according to Tsalkin (1938a, p. 217) sometimes attained as much as 5000 individuals.

For the characteristic distribution of the common dolphin in the eastern part of the Black Sea for the summer-fall period, I present Figs. 35-39 borrowed from Tsalkin's work indicated above.

According to Golenchenko's (1949) data, the distribution of the dolphin in recent years is somewhat different, i.e. it is not constant. I will not dwell on details at the moment; it is only important to emphasize that large concentrations of dolphins are disclosed not only in the littoral zone, but in the open sea as well, far from the coastlines. Apparently, this dolphin can live far from the coastlines even in the other parts of its range. W. Turner's (1880) data give some indications to this effect, in accordance with which an expedition on the "Challenger" conducting dredging operations in localities of the Pacific and Indian Oceans quite remote from the mainlands obtained bones of the ear of only Delphinus in the dredgings.

As a result, the common dolphin, being a typical pelagic species according to the nature of feeding, inhabits practically all of the Black *139 Sea water area, forming concentrations in those places where its food supply is concentrated at the time.

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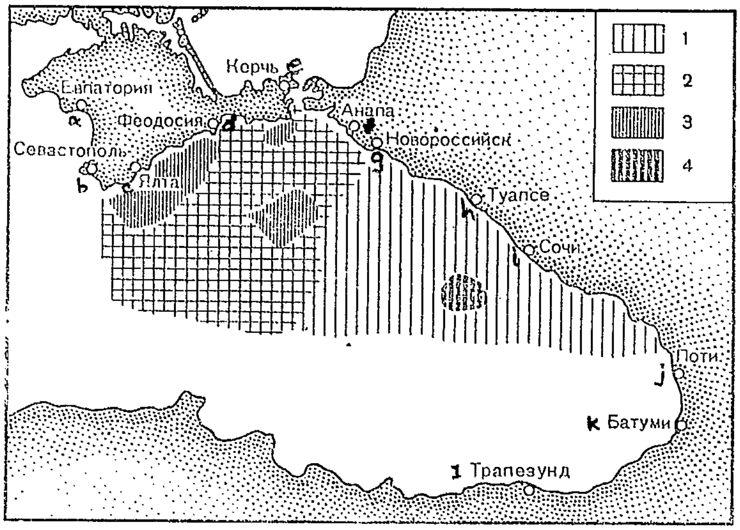

Distribution of Delphinus in June

Рис. 35. Распределение белобочки в июне 1936 г. (по В. И. Цалкину):

1 — встречается очень редко; 2 — редко; 3 — часто; 4 — очень часто.

Figure 35. Distribution of the common dolphin in June of 1936 (by V. I. Tsalkin):

Key to Fig. 35:

1) occurs very rarely 2) rare 3) commonly 4) very commonly

a) Yevpatoria b) Sevastopol c) Yalta d) Feodosiya e) Kerch f) Anapa

g) Novorossiisk h) Tuapse i) Sochi j) Poti k) Batumi l) Trabzon

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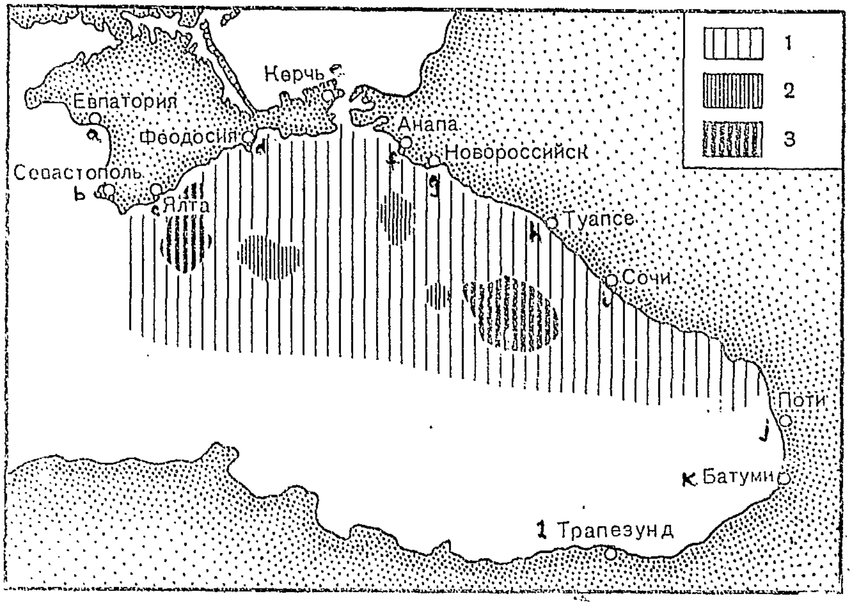

Рис. 36. Распределение белобочки в июле 1936 г. (по В. И. Цалкину):
1 — встречается очень редко; 2 — часто; 3 — очень часто.

Figure 36. Distribution of the common dolphin in July, 1936 (by V. I. Tsalkin):

Key to Fig. 36:

1) occurs very rarely 2) commonly 3) very commonly

a) l, same as in Fig. 35

From the preceding section, it was evident that during the winter and in the spring the basic food of the dolphin was anchovy.

According to Tsalkin's data (1938a), during the summer and in the fall of 1936, stocks of dolphin were found around the concentrations of sprat.

The stomachs of the dolphin caught from large stocks contained up to 99.6% sprat. The food of animals from more dispersed concentrations was more diverse, but sprat was also basic in their feeding.

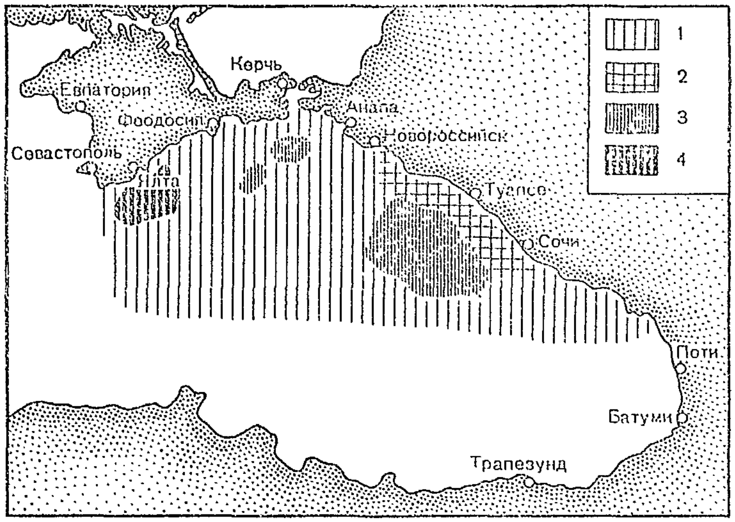

Рис. 37. Распределение белобочки в августе 1936 г. (по В. И. Цалкину) Обозначения те же, что на рис. 35.

Figure 37. Distribution of the common dolphin in August, 1936 (by V. I. Tsalkin). Designations same as in Fig. 35.

According to Freund's data (1950), the sprat, beginning in May, constituted 96% of the food of the common dolphin throughout the entire summer. One can assume then that the distribution of the common dolphin in the Black Sea is conditioned by the distribution of the food supply which is basically anchovy and sprat. Winter concentrations of dolphin near the southern Caucasian coastline and near the south-western coast of the Crimea are confined to the localities of the winter stay of the anchovy; the summer concentrations - to the concentrations of sprat. Freiman (1950) gives the same pattern of distribution for the dolphin.

Due to the fact that the migrations and the manner of life of the anchovy have been better studied by ichthyologists, than that of the sprat, predictions of winter concentrations of dolphin are already becoming real. As regards to the summer distribution of the common dolphin, one can only base himself only on empirical data.

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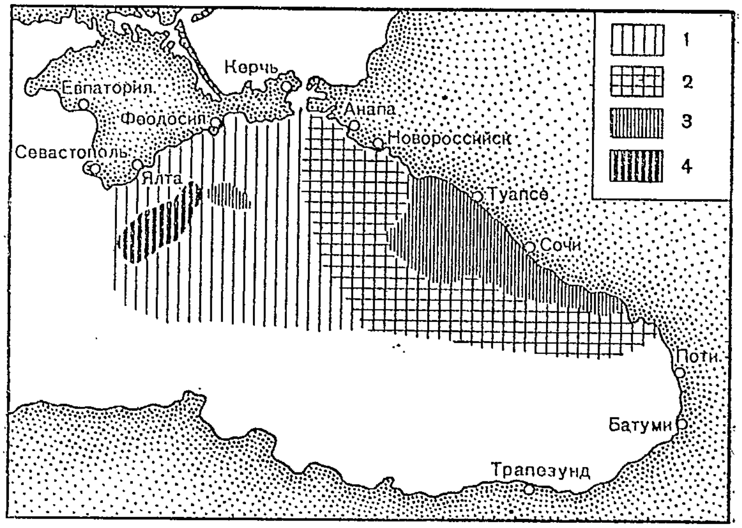

Рис. 38. Распределение белобочки в сентябре 1936 г.
(по В. И. Цалкину).
Обозначения те же, что на рис. 35.

Figure 38. Distribution of the common dolphin in September of 1936 (by V. I. Tsalkin). Designations same as in Fig. 35.

Mass tagging of animals could have facilitated the clarification of the regularities of dolphin migrations. However, attempts in this direction undertaken by the Sevastopol and Novorossiisk Biological Stations (Mal'm, 1933a) including VNIRO (Tsalkin, 1935) did not provide the necessary results, evidently because of the insignificant numbers of tagged animals. *141

In contrast to the common dolphin, the other two dolphins are distributed only throughout the littoral zone and never occur in the open sea.

Let us now examine the distribution of the harbour porpoise in the basin.

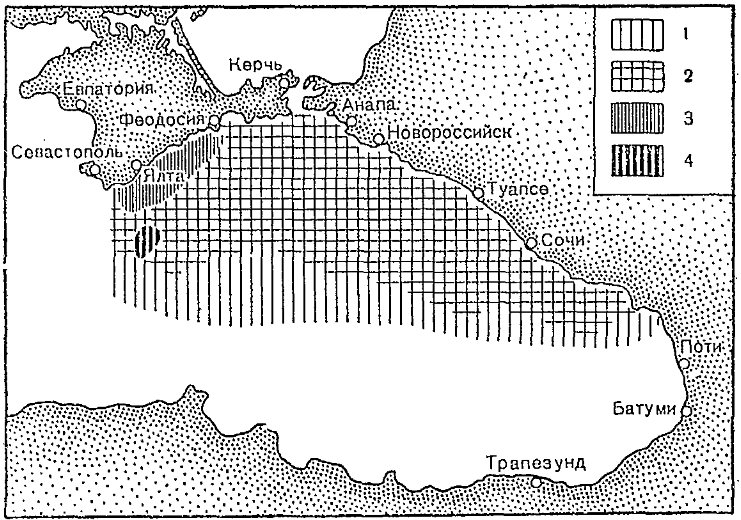

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Рис. 39. Распределение белобочки в октябре 1936 г. (по В. И. Цалкину). Обозначения те же, что на рис 35.

Figure 39. Distribution of the common dolphin in October of 1936. (By V. I. Tsalkin). Designations same as in Fig. 35.

This dolphin, as was already noted, occurs in greatest concentrations in the Sea of Azov and the Kerch Strait.

According to Tsalkin (1940), it is distributed basically "in the southern sections of the Sea of Azov, the Kerch Strait and the expanse of Black Sea immediately preceding the Kerch Strait" (p. 160). The distribution of this dolphin is confined to the littoral shoal waters.

Due to the systematic migrations, the distribution of the dolphin throughout the year changes drastically. Thus, in the fall it leaves the Sea of Azov following the Azov anchovy into the Black Sea where, feeding on the anchovy, it over winters in the littoral zone. Judging by the fact that this dolphin occurs near Batumi, the region of which the Azov anchovy never reaches, it also feeds on Black Sea anchovy as well. In the spring, usually in April, the dolphin returns to the Sea of Azov and the Kerch Strait where it remains till the Fall.

Such is the pattern of migration of the main mass of the dolphin of this species.

Tsalkin (1940) notes that a certain portion of the dolphins sometimes spends the winter in the southern regions of the Sea of Azov and the Kerch Strait where the limit to their stay is set by the formation of a solid ice cover. "Nevertheless," writes Tsalkin (1940), "even in the years when the Straits do not freeze over, a considerable portion of the sea pigs leave its confines, following the Azov anchovy moving to their wintering grounds located in the littoral waters of the Crimea and Southern Causcasia" (p. 165).

In exactly the same way, this dolphin sometimes occurs in very small numbers in the pre-estuarine expanses of certain Black Sea rivers in the summer as well.

It should be noted that the harbour porpoise does not avoid fresh waters and often enters rivers; at times, for very long distances from the mouth.

In the Azov-Black Sea basin, it often does not avoid extremely desalnized sections. Thus, Ostroumov (1898) already pointed out that "instances *142
of entry of such a large marine animal as the 'sea pig' (Phocaena communis) was observed by fishermen even near Ismail" (p. 168).

This dolphin was established by Zernov (1913a) for the Sevastopol shores; for the Rumanian coast by L. Borcea (1935); and for the coasts of Bulgaria and Turkey by Davedzhan (1926) and Nachaev (1930).

N. Borodin (1902) and Kravchenko (1932) indicate occurrences of this dolphin near the Batumi shores where I had the occasion of observing it as well (1936). Freiman (1950) noted it near the Poti shores.

It should be indicated, it is true, that in the Batumi region, I was sucessful in observing the harbour porpoise only in March and the very beginning of April, i.e. before the main mass of harbour porpoises begins to leave the Black Sea for the Sea of Azov. In 1935, when I had the occasion to sail in this region regularly (1941), I did not once encounter the harbour porpoise here later than the latter half of April - the beginning of May. Consequently, it can be considered that only an insignificant portion of the population remains both in the Azov Sea and Kerch Strait for the winter (when they do not entirely freeze over), and in the Black Sea for the summer. The main mass of animals migrate according to the pattern outlined above.

The bottle-nose dolphin is also distributed only throughout the littoral zone and never occurs in the open sea. It is confined mainly to the north-western section of the Black Sea. During the migration of the Azov anchovy, the bottlenose occurs in the area of the Black Sea before the Strait and also in the Kerch Strait as well. In the summer on the other hand, the bottlenose occurs more often near the southern coast of Crimea and near the coast of Southern Caucasia.

It is interesting that the concentrations of bottlenose are confined to the western section of the eastern region more typical of the Black Sea where benthos predominates, according to L. I. Yakubova's (1935) data.

Such a limited distribution of the bottlenose in the Black Sea is quite understandable if one takes into consideration the benthonic nature of feeding of the animal and the distribution of the benthos in the Black Sea. As is well-known, because of the contamination of the deep waters with hydrogen sulphide, the entire benthos is concentrated in the littoral section of the water body. According to Nikitin's data (1938), the lower boundary of the benthos in the region of the southern shore of the Crimea runs "for the most part at a distance of 5-10 miles from the shore...In places, the boundary extends for 24-26 miles from the shore"(p.342). Along the coastlines of the Caucasus, the lower boundary of the benthos runs "for the most part at a distance of 3-5 miles from the shore. In the northern section, the boundary extends for 10-15 miles: and in the southern sections, at times it approaches the shore within a distance of one mile and *143 even 0.5 mile" (ibid. p. 342).

As I have noted, the bottlenose occurs more often near the shores of the Northern Caucasus and near the shores of southern Crimea, i.e. precisely where according to Nikitin (1938), the lower boundary of the benthos is farthest away from the shores.

Having examined the presented data, it can be said that the common dolphin, having a pelagic nature of feeding, inhabits practically all of the water area of the Black Sea. The benthophagous harbour porpoise and the bottle-nose dolphin are distributed only throughout the littoral zone, the harbour porpoise being confined to the shallow water localities of the Sea of Azov and the Kerch Strait, whereas the distribution of the bottlenose is not limited by this factor. In the Black Sea, it is well-known, great depths approach near the shore.

As essential difference is noted in the nature of the distribution of the dolphins. The common dolphin, feeding on aggregated food, forms large concentrations, while the harbour porpoise and the bottlenose, feeding on non-aggregated fishes, usually keep to small dispersed schools and concentrate only during anchovy migrations.

Thus, the distribution of the animals in the water body is directly related to the nature of feeding.

The difference in nutrition determines the dispersion and the distribution of the individual forms, which in turn determine the various factors of morality and a different abundance of populations of the individual forms in the basin, but I will discuss this in more detail later on.

3. REPRODUCTION AND MORTALITY FACTORS

A study of the anatomy of the reproductive system of the dolphins did not enter directly into the undertakings of the present work especially as it has been treated in sufficient degree in studies by L. Bordos (1899), G. Paladino (1903), R. Anthoni (1922), B. Howell (1930), W. Pycraft (1932), E. Slijper (1936), M. M. Sleptsov (1940, 1941), A. Meek (1929) and other authors.

The ovaries of the females are small in size. The walls of the bicornuate uterus are very elastic since the newborn dolphins in comparison to size of the mother are very large. The testicles in the males, located in the body cavity, vary highly according to size and become enlarged considerably during the mating season.

The walls vaginalis uterus are furnished with special folds which protect the uterus from the entry of water during the sexual act which is consumated in the water.

For a long time it was not established whether the offspring in the *144
Cetacea emerge headfirst or tailfirst. According to a few observations,

the offspring emerges tailfirst in beluga and harbour porpoises.

I have many times observed Black Sea dolphin giving birth in the seine nets and the newborn always came tailfirst. Sleptsov's (1940) observations confirm this as well. Tomilin (1951) even presents a photograph of the moment of birth in the bottlenose on which it is clearly visible that the newborn emerges tailfirst. F. S. Essapian (1953), describing births and the behavior of new-born dolphins, also presents a photograph of the moment of birth where the same picture is distinctly visible. Thus, the issue of the position of the offspring at the moment of birth in dolphins can be considered established once and for all.

Such a position of the newborn during birth, opposite to that of all terrestial mammals can be considered as an adaptation to life in the water. The point is that in the embryo, the fins are not extended: the dorsal fin is pressed against the body (Fig. 40) and the flukes of the caudal fin are rolled up (Fig. 41). The fins are exactly in such a position during the first moments in the newborn. Because of this, the young dolphin during the initial period after birth cannot move around on its own. Due to its low specific gravity it does not sink but floats like a buoy - head up. The newborn remains in such a position for some time after which the fins extend and it begins to move around independently in the water together with the mother.

As a result, the body of the newborn in dolphins at birth sinks into the water while the head remains above its surface allowing it to breathe unhindered immediately. On the other hand, with an opposite position of the young at birth incapable of movements in the water, it would inevitably have choked on the first breath since its head would have been in the water.

Mal'm (1932) and Khvatov (1938) maintain that the newborn, during the first several days, remains attached to the body of the mother by the umbilical cord. Obviously this statement applies to premature births, since during normal births, as my observations showed, and confirmed by Ṡleptsov's data (1940), the umbilical cord is severed immediately after birth. In 1948 in the Yalta region, a school of females with newborn were caught. An examination of the young and the birth canals of the females showed that in 24 of the females births had occurred on the day of the catch, but nevertheless, I did not discover a single newborn which was attached to the body of *145
the mother by the umbilical cord.

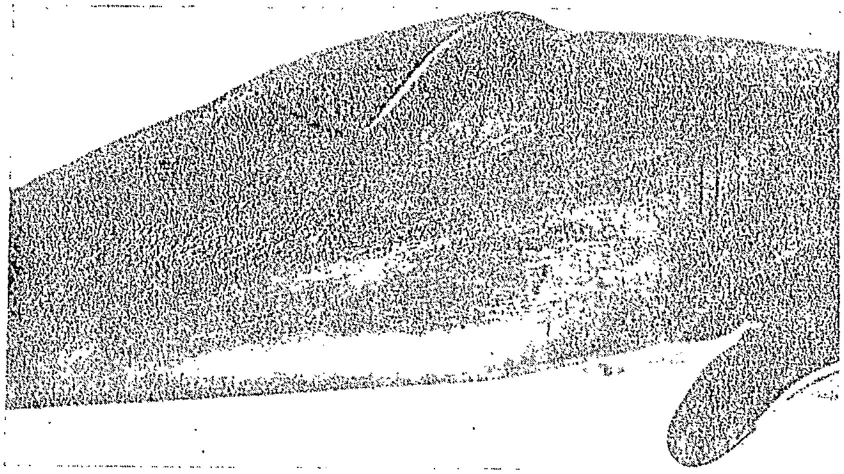

Рис. 40. Положение спинного плавника у эмбриона (оригин.).

Figure 40. The position of the dorsal fin in an embryo (origin.)

According to Mal'm's observations (1932), "during this period the dolphin swims along with its mother holding on to its pectoral fin with its teeth" (p. 14). This is a clear fabrication on the part of the author, since a new-born dolphin has no teeth at all. They begin to erupt later on.

The same should be said regarding the hemophilia which Mal'm (1932) and Khvatov (1938) ascribe to dolphins.

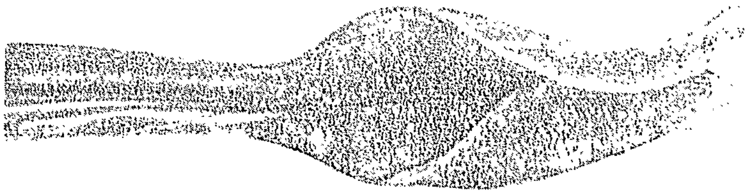

Рис. 41. Положение лопастей хвостового плавника у эмбриона (оригин.).

Figure 41. Position of the lobes of the caudal fin in an embryo (origin.)

The structure of the mammary gland of the cetaceans was dealt with in the works of Lillie (1915), H. Mackintosh and F. Wheeler (1929) and other authors. The circular muscle surrounding the mammary gland, apparently con- *146 tracts involuntarily upon being nudged by the snout of the young. As a result of the contraction of this muscle, the milk squirts out through the nipple.

In 1932, on the Kanin Peninsula, I succeed in eliciting a milk-yielding response in a dead beluga, but one that had just been killed, by nudging the mammary gland with the toe of my boot or with a fist. Immediately after the nudge the milk squirted from the nipple literally in a continuous fountain for 5-7 seconds. Thus, it is not necessary for the young to suck out the milk, for which its mouth, lacking soft lips, is not adapted.

The newborn feeds apparently for a short period of time, but very often, to which McBride (1940) indicates. According to his observations in the Florida oceanarium, the bottlenose feeds its young round the clock every 15-30 minutes.

The rapid growth of the dolphins in the initial period of life, including compensation for the great heat loss in an aquatic environment, are provided for by the enormous amount of fat contained in the milk. The fat content of the milk of cetaceans, including the dolphin, reaches 44-46%, and according to Zernov's data (1938) - even as high as 53.04 % (in grey whales). In order to appreciate these figures, it is sufficient to note that the highest fat content of cow's milk in exceptional cases only goes as high as 6-7% and on the average does not exceed 3-5%.

The first authentic information regarding the reproduction of the Black Sea dolphin belongs to Silant'ev (1903) and Zernov (1913a). Appearing later are studies by Maiorova and Danilevskii (1934), Mal'm (1936), Mal'm and K. T. Trotskaya (1936), Sleptsov (1940, 1940a, 1941), V. E. Sokolov (1954), on the reproduction of Delphinus and a work by Tsalkin (1940) on the reproduction of the harbour porpoise.

Sexual maturity in common dolphin males occurs at the age of 3-4 years. The size of the animal in this respect is not always indicative. Thus a certain number - a very small one it is true - of males are sexually mature in the size class 150-160 cm, while at the same time, in the class 171-180 cm, can be found animals not yet sexually mature. Nevertheless, the main body of sexually mature males have a length of 170 cm and up. Animals, on the other hand, of 181 cm and up are always sexually mature.

In the females, sexual maturity apparently occurs earlier - toward the third year of life. Just as within the males, the size of the animals here varies greatly. It is possible to find females with a length of 140-150 cm already pregnant. At the same time, I was able to find females in the 161-

170 group not yet sexually mature, and Sleptsov (1941) was able to find the same in the class 161-165 cm. The main body of females of this length, *147 as a rule, are sexually mature. All of the females exceeding that length are always sexually mature.

Mating, and consequently calving, in Delphinus are highly extended in time, a fact noted by all authors. Judging by own data, the height of the mating season of this dolphin falls in July. Sleptsov (1941) indicates July, August and the first half of September with an extension of the period of mating from June to October.

Calving time according to my data extends over a period from May to September with the peak in May and June; according to Sleptsov (1941), it is confined to June-July.

Thus, the gestation period in the common dolphin can be fixed to a period of 10-11 months.

Milk feeding of the young apparently lasts for 6 months, besides which in the stomach of suckers along with the milk, I had occasion to find remains of fish; a fact noted by Sleptsov (1941) as well. Consequently, the young dolphin changes to independent feeding while continuing to feed for a short period of time on the milk of the mother.

There are varying points of view regarding the intensity of reproduction in the common dolphin. Mal'm (1936) considers that they reproduce twice in three years. According to Maiorova and Danilevskii (1934), twice in four years. Many, including Sokolov (1954) maintain, without sufficient bases incidentally, that the common dolphin calves annually. Adhering to a different point of view, Sleptsov (1941) considers that the dolphin calves for three years running; during the fourth year the female remains barren.

My own materials corroborate Sleptsov's (1941) conclusions. In the summer of 1946 in Yalta, Anapa and on Utrish, I examined the reproductive systems of 1516 females. Of that number of sexually mature females, 751 were parous, of which 183 were barren. Thus it can be considered that within the sexually mature females, about one quarter do not participate in reproduction which corroborates the periodicity of reproduction established by Sleptsov (1941).

The period of reproduction in the harbour porpoise is also greatly extended. According to Tsalkin's data (1940), this dolphin mates during the period from July to October and calves from April to June. He determines the gestation period to be 9-10 months. Tsalkin (1940) considers that the main body of sexually mature females reproduce annually.

The onset of sexual maturity in the harbour porpoise, as in the common dolphin is not connected with a particular size of the animal. Pregnant *148
females with a length of 130 cm and higher occur. Beginning from 150 cm, all of the females, according to Tsalkin (1940) are already sexually mature. It has not as yet been possible to correlate these data with the age of the animals.

There are few data on the reproduction of the Black Sea bottlenose because its catches are rare. Nevertheless, it can be noted that the periods of reproduction in this dolphin are evidently just as extended as in the other Black Sea dolphin. Zernov (1913a) noted lactating, i.e. suckling bottlenose females on November 20 and January 31. In a catch on May 16, 1948 in the Yalta region, I came across three lactating females with lengths of 228, 232 and 234 cm. In the same catch, there was a single pregnant female with a length of 226 cm. The length of 226 cm. The length of the embryo was 89 cm. And in June, 1934, I saw two embryos of this species with lengths of 98 and 101 cm. Freund (1932) indicates the length of a newborn of this species of about 1 m which apparently is in accordance with fact.

With respect to the common dolphin, I came across newborn with lengths of 82-85 cm, but I also came across embryos with lengths of 89-90 cm. Thus, the length of the newborn in this species can be taken as 82-90 cm.

According to Tsalkin (1940), the length of newborn of the harbour porpoise is 82-85 cm.

One's attention is drawn to the very large dimensions of the newborn in comparison to the length of the body of the mother. While in the bottlenose this dimension is somewhat less than half the body length of the mother, in the common dolphin it is on the average, half the length of the mother with deviations in both directions. In the harbour porpoise on the other hand, the length of the newborn is often more than half the body length of the mother. Zernov (1913a) had already pointed out this fact.

Turning to the mortality of the dolphin in the Azov-Black Sea basin, it should be noted first of all that the populations of all three species of dolphin live in the basin without being subjected to attacks by predators. Instances of attacks on the young by adult memebers are also totally absent.[1]

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[1] It is true that inspite of all the facts, one author (N. Dudin, 1930) maintains that a female, having borne one young "at length and selflessly protects it from attack by its fellow members..." (p. 34), however this statement can be regarded as a fabrication without any basis, with which, unfortunately the article abounds despite the fact that under the subtitle appears "An Essay by a Naturalist". Moreover, in a work by the Rumanian researcher Z. Popovici (1939), it is indicated that a Black Sea shark supposedly feeds on dolphins. I think that this can pertain only to dead or wounded dolphin. Knowing the insignificant size of the Black Sea shark, it is inconceivable that it could feed on dolphins which by far exceed it in size.

The absence of attacks by predators does not indicate that the eliminating factor is only the industry. Notwithstanding the insufficient level of our knowledge regarding the causes of mortality in dolphins, we will nevertheless attempt to examine the issue as it applies to each species taken separately.

Examining these factors for the common dolphin, let us turn first of all to the helminthological data. While until the present time we had at our disposal the only, but nevertheless general work by L. Borcea (1935) in this area, at the present time, thanks to the studies of Delamure (1941, 1945, 1946, 1950, 1951, 1951a, 1952, 1955) indicated earlier everything has become much clearer.

In 1946, after a prolonged interruption of the industry due to the war, while dissecting lungs of the common dolphin, I was astonished by the fact that the lungs of a large number of animals created the impression of being affected with tuberculosis; one of the lungs in many animals being completely destroyed. This pattern, it turns out, was caused in the lungs of the common dolphin by the nematode <u>Scrjabinalius</u> <u>cryptocephalus</u> localized in a round calciferous capsule formed from the tissue of the host. As a result, even to the touch, the lungs of an infested dolphin felt as though they were stuffed with peas. A photograph of a dissected bronchus of a common dolphin gives an idea regarding the localization of this parasite. (Fig. 42). *150

According to Delamure's data (1952), on the average of 28.13% of the dolphin that are caught are infested with this parasite. The degree of infestation of the various schools of animals is not the same and fluctuates between 16.9 to 39.0%. The reasons for these fluctuations are not clear as the biology of the parasite is thus far unknown. The number of nematodes established by Delamure in one lung fluctuates from 3 to 227.

The opened bronchus of [illegible]

Рис. 42. Вскрытый бронх белобочки, зараженной скрябиналиозом
(по С. Л. Делямуре).

Figure 42. A dissected bronchus of a common dolphin infested with <u>skryabinaliosis</u> (by S. L. Delamure).

According to the author's data, the embryos and sucklings are completely sterile; the invasion of the young animals is negligible. On the other hand, the lungs of animals of average age are highly infested. Hence, Delamure (1952, 1955) considers that sanitation of the population is possible by means of decreasing the number of individuals of average and in part, older age groups, which are the main sources of infestation of the external environment with larvae of S. cryptocephalus. Since it is precisely these age groups that constitute the industry, then, according to Delamure's conclusion, it is necessary to intensify the catches.

That the invasion by this parasite can prove fatal to the animal is evidenced by the results of the dissection, conducted by Delamure, of seven dolphin cast up on the shore (1955). In the absence of traces of wounds on the body of the animals, their lungs in all cases were intensely invaded by the indicated nematode, besides which there was much light-yellow pus in the bronchi and the trachea of these animals, in places filling the lumens of the small respiratory passages.

According to a patho-anatomical dissection conducted by S. L. Dzhanumov and M. R. Normark "the mucosa of the bronchus is completely absent. The helminth adjoins directly to the partially destroyed muscle layer (in places the ingrowth of the parasite into the mass of muscle fibres is evident). Behind the muscle layer, there is an inflamed, primarily leukocytic infiltration. In the infiltrate, here and there, are small remnants of cartilage". Yu, G. Tsellarius, doing a patho-anatomical analysis of pieces of an infested lung from another specimen, came to the conclusion that "in the periphery of the capsule (containing the anterior end of the body of the parasite) in the lung tissue are observed symptoms of a sharply pronounced, primarily active inflammation in the direction of the periphery, subsiding in intensity and taking on a more exudative character. The small bronchi are in a state of active endobronchitis and peribronchitis; the epithelium lining them, in the majority of cases is absent. Many bronchi are completely obturated, others contain an exudate, abundant with cellular elements of the histocytic type" (S. L. Delamure, 1955, p. 477).

As is evident, both of these conclusions are in essence very similar. It is quite obvious that a concentration of this parasite causes an inflammatory process in the lungs of the host which is why this pattern *151 internally resembles tuberculosis. It is also quite evident that a concentration of large numbers of the nematode is always fatal to the host-animal. Consequently, one of the essential factors in the mortality rate of the common dolphin in the Black Sea is helminthiasis. It should be mentioned (see first chapter) that the nematode which was being discussed is specific only to the Black Sea dolphin and is not found in other localities of the range of the common dolphin.

Besides helminthiasis, the Black Sea common dolphin suffers from other diseases. Very often in the vaginalis uterus, I had occasion to find something like calciferous formation; round in shape and considerable in size, at times 2-2.5 cm in diameter. Sleptsov (1941) and Sokolov (1953, 1954) also noted this phenomenon. Nevertheless, there has been no success in resolving the nature of these formations.

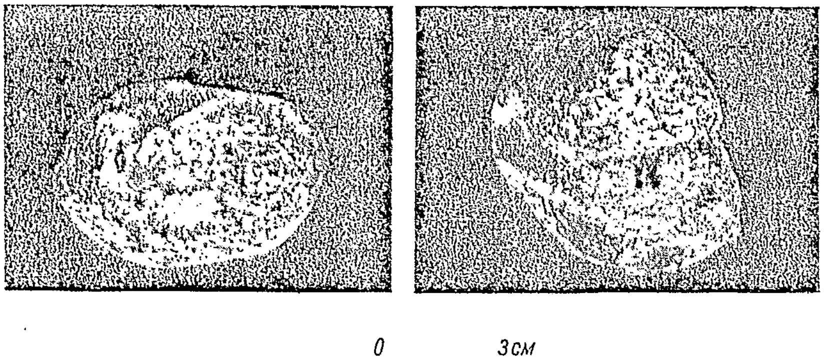
In 1948 in Yalta, I extracted from a ureter of a common dolphin a large round stone the shape and size of which is presented in Fig. 43. The ureter in the place where the stone was located was sharply hypertrophied. The corresponding kidney was clearly degenerated but no stones were found in it. The other ureter was within norms but then in the corresponding kidney, 17 small stones no bigger than a person's fingernail were disclosed.

There is no doubt that such a disease of the excretory system affects the animals with disastrous results.

Helminthiasis occurs in the other Black Sea dolphin as well, but in these dolphins it does not cause such catastophic pathological anatomic changes in the vital organs, as for example the lungs, which occurs in the common dolphin.

Of the other Black Sea dolphins, the bottlenose suffers from helminthiasis to a lesser degree - and the harbour porpoise to a greater degree.

On many occasions I heard from fishermen that the Azov dolphin is deaf and during seine net catching does not respond to the "telephone"[1]. In all fairness, I had occasion to become convinced of this statement personally while taking part in the catching operations of the porpoise. This fact and also the dispersal and the slowness of movement of schools, place a unique impression on the nature of the industry involving this dolphin.



[illegible] ureter [illegible] Delphinus.

Рис. 43. Камень из мочеточника белобочки (оригин.).

Figure 43. A stone from the ureter of a common dolphin (origin).

The cause of deafness in the dolphin now is quite clear thanks to the heminthological studies. According to Delamure's data (1941, 1945, 1955) a school of Azov dolphin is 100% affected with stenuriasis caused by the nematode Sternurus minor (Kühn). Concentrating intensely in the auditory canals and nasal passages of the dolphin (from 28 to 1682 specimens in a single animal, and on the average of up to 810 specimens) this nematode primarily affects the auditory organs. Apart from the auditory canals, the parasites *152

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[1] The "telephone" is a unique practice within the industry, the description of which is given in the first section of this chapter.

cause pathological anatomic changes as well, visible macroscopically (hemorrhaging, thickening of tissues, etc.) It is evident of course, that even if this nematode is not a direct cause of the destruction of the animals, then affecting such an organ as the organ of hearing vital to cetaceans, it complicates considerably the existence of the Azov dolphin.

Inasmuch as the organ of hearing in cetaceans is simultaneously an organ of equilibrium, and orientation in the water, then it is possible to assume (I emphasize - for the time being, to assume) that precisely this nematode causes mass destruction of the dolphin during rapid formation of ice cover when the animals do not have time to escape from under the ice and suffocate.

Such instances occurred in the Sea of Azov and the Kerch Strait when they froze rapidly.

A. P. Pritula informed me of one such case having occurred yet prior to 1941, and of another case in 1944-45, related to me by G. D. Pichko.

In the anthology "Fauna and Flora" (Fauna och Flora, 1940) a similar case is presented for the Baltic Sea; and for the Danish waters, this is described by A. Johansen (1929).

Finally, besides helminthiasis for the littoral forms, particularly *153
for the bottlenose, it is possible to assume the presence of a higher mortality rate of the newborn compared with the common dolphin. In the literature, this implication was first expressed by Tsalkin (1940a).

The point is that the newborn for the first while stay on top of the water due to their low specific gravity and are incapable of active movement. It is quite natural that during this time, swells in the sea can be disastrous for them since they inevitably hamper the act of breathing. In addition to that, in the summer during the period of births in the dolphin, disturbances due to coastal breezes are very frequent in the littoral zone of the Black Sea. In the regions removed from the coasts, these winds are not felt and swells therefore are not observed.

Our material confirms that sexually mature females of the common dolphin completely drop out of the industry for the period of calving. The industry during this period continues almost exclusively on account of the males and sexually immature females, a fact noted in the literature as well. Apparently, the females leave the region of the catching operations, i.e. the littoral zone, for the period of calving. Finally, Tsalkin (1938a, 1940a) from a plane observed schools of common dolphin in the open sea consisting entirely of females and their young, which confirms the departure of the common dolphin females for the period of calving from the zone of influence of the coastal breezes in the open sea.

While such a departure is possible for the pelagic common dolphin the littoral forms, as was already noted, never occur in the open sea. Thus the newborn of the littoral forms find themselves in considerably worse conditions than the newborn of the common dolphin which could entail an increased "infant" mortality rate.

It appears that this factor affects the bottlenose more intensely which calves in the Black Sea, than it does the harbour porpoise which calves in the Sea of Azov.

Winding up the examination of the mortality factors in the dolphins in the conditions of the Azov-Black Sea basin, it should be emphasized once again that I do not consider it exhausted by no means. I only listed those factors which have been revealed at the present time by the contemporary level of our knowledge. This remark particularly concerns the bottle-nose dolphin since the biology of this species has been studied considerably less than the biology of the other forms.

Let us attempt to sum up as briefly as possible some of the results. Before us there are three species of dolphin inhabiting the same water body, feeding on fish, i.e. living one should think, in the same conditions. In addition to that, the material presented above indicates that there are *154 quite specific and substantial ecological differences among the species, beginning with nutrition.

The nature of feeding determines the distribution of the animals in the water body. A clearly pelagic form - the common dolphin - populates practically the entire water area of the Black Sea, occurring both in the littoral zone and in the halistatic regions. Consequently, the nature of feeding in this dolphin allows it, in the conditions of the Black Sea, to inhabit a considerably greater area in comparison with the other forms which corresponds to its greater abundance in the water body as well. A clearly benthonic form, the bottlenose, by virtue of the nature of its feeding and the uniqueness of the Black Sea, is restricted in its distribution only to the littoral zone, occurring primarily in those places where the lower boundary of the benthos is farthest away from the coastlines. As a result, the area of distribution of this dolphin in the Black Sea is very restricted, which corresponds to its small abundance in the water body. Finally, the Azov dolphin feeds mainly on benthonic food, but only in the shoal waters of the Sea of Azov and the Kerch Strait. Finding itself in the Black Sea, this dolphin changes to pelagic food in the event that the food is concentrated in the littoral zone. Thus, the distribution of the harbour porpoise is also restricted only to the littoral zone. Due to the population of the

Sea of Azov and the Kerch Strait by this dolphin, the area of distribution becomes greater than the area of distribution of the bottle-nose dolphin, which corresponds as well to its greater abundance in comparison with the latter species.

The differences in the nature of feeding also determine the dispersion of the animals. The common dolphin, feeding on pelagic food which forms schools, usually keeps to large aggregations. The benthophagous bottlenose and the harbour porpoise usually keep to small groups and only in cases of concentrations of anchovy in the littoral zone do they form schools. They are nevertheless inferior in abundance to the schools of common dolphin.

The nature of the behavior in the Sea is also sharply distinct. The pelagic form - the common dolphin - always moves with great speed, frequently appearing on the surface. The benthophagous bottlenose and the harbour porpoise usually move slowly, appearing less frequently on the surface, and in cases of their being alarmed, they hide in the water for long periods of time due to their capacity for longer dives.

Finally, the differences in the nature of the distribution determines the different factors of mortality, affecting differently the population numbers. The common dolphin, capable of being both in the littoral zone as well as in the open sea, has the opportunity of retreating from unfavorable hydrometeorological conditions. Its sole factor of mortality, apart from *155
other causes, is helminthiasis. For the littoral forms, this possibility does not exist, and one can assume that in comparison with the common dolphin there is a considerably higher "infant" mortality rate besides helminthiasis. For the harbour porpoise, also apart from helminthiasis, instances

of mass destruction under the ice are well-known, reflecting on the population numbers in a manner similar to an epizooty, which is completely unkown to the common dolphin.

Thus, the dolphins that we examined are three ecologically different forms characterized briefly by the following.

The common dolphin - pelagic and most numerous form; inhabits the entire water area of the Black Sea. Usually keeps to large schools. Moves very rapidly, appearing frequently on the surface.

The bottle-nose dolphin - typically benthonic and least numerous form; inhabits only the littoral zones of the Black Sea. Usually keeps to small groups. Moves slowly, rarely appears on the surface, able to make prolonged dives.

Harbour porpoise - basically benthonic form, but only in shallow water conditions. In the Black Sea, feeds on pelagic food. According to abundance, considerably inferior to the common dolphin but outnumbers the bottle-nose. Inhabits the littoral zones of the Sea of Azov, the Kerch Strait and the Black Sea. Usually keeps to small groups. Moves slowly, rarely appearing on the surface.

It stands to reason that these differences must exist in connection with morphological and physiological characteristics specific to every species.

For an examination of these characteristics let us turn to the next chapter.

CHAPTER III

ECO-MORPHOLOGICAL AND PHYSIOLOGICAL CHARACTERISTICS OF THE DOLPHINS OF THE BLACK AND AZOV SEAS

1. A REVIEW OF THE LITERATURE ON THE PHYSIOLOGY OF RESPIRATION IN DIVING ANIMALS

The physiological characteristics of respiration in diving animals *156 are enormously interesting in themselves. In addition to that, it is with great regret it must be admitted that here, physiology has badly fallen behind morphology and anatomy. The last bulletin on comparative physiology by Kh. S. Koshtoyanets (1950), where only several pages were set aside for the characteristics of respiration in diving animals, can serve as clear evidence of this.

The information reported by Zernov (1934) is concerned to a greater degree with the characteristics of the thoracic cage and the respiratory passages of acquatic mammals.

E. M. Kreps' (1941) article, specially devoted to the issue being discussed here, is very interesting, but is extremely laconic and lacking any original material and is a review of foreign literature.

Such a neglect of research into the physiology of acquatic animals has no justification, for this area is extremely interesting and important for the solution of many theoretical and practical issues and it is very easy in our circumstances to conduct any physiological experiments.

The Cetacea, due to their thick subcutaneous fat layer, and despite the great difference in the temperatures of the body and the external environment, have a constant and besides, a fairly high body temperature. According to the data Guldberg (1900-1901), Kellog (1928), Zenkevich (1938a), *157

Tomilin (1947, 1948), the body temperature in the Cetacea fluctuates from 35.5 to 38.8°. In agonal animals, the temperature is at times 40° and at times 42.6°.

Maintaining a constant temperature and having no hair cover such as other aquatic animals, the cetaceans have a capacity to dive for an incomparably long time.

For a comparison of the duration of dives of various aquatic mammals, I am presenting Table 21 borrowed from L. Irving (1939, p. 115).

Table 21

Duration of dives of aquatic mammals.

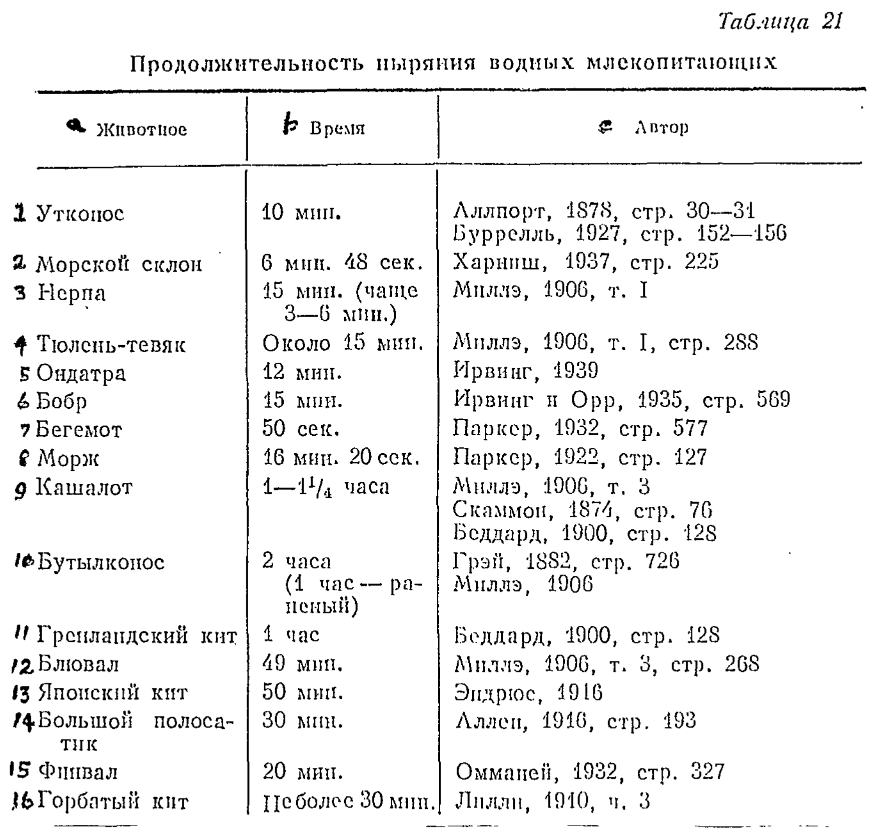

Таблица 21

Продолжительность ныряния водных млекопитающих

a Животное	b Время	c Автор
1 Утконос	10 мин.	Аллпорт, 1878, стр. 30—31 Буррелль, 1927, стр. 152—156
2 Морской склон	6 мин. 48 сек.	Харниш, 1937, стр. 225
3 Нерпа	15 мин. (чаще 3—6 мин.)	Миллэ, 1906, т. I
4 Тюлень-тевяк	Около 15 мин.	Миллэ, 1906, т. I, стр. 288
5 Ондатра	12 мин.	Ирвинг, 1939
6 Бобр	15 мин.	Ирвинг и Орр, 1935, стр. 569
7 Бегемот	50 сек.	Паркер, 1932, стр. 577
8 Морж	16 мин. 20 сек.	Паркер, 1922, стр. 127
9 Кашалот	1—1¼ часа	Миллэ, 1906, т. 3 Скаммон, 1874, стр. 76 Беддард, 1900, стр. 128
10 Бутылконос	2 часа (1 час — раненый)	Грэй, 1882, стр. 726 Миллэ, 1906
11 Гренландский кит	1 час	Беддард, 1900, стр. 128
12 Блювал	49 мин.	Миллэ, 1906, т. 3, стр. 268
13 Японский кит	50 мин.	Эндрюс, 1916
14 Большой полосатик	30 мин.	Аллен, 1916, стр. 193
15 Финвал	20 мин.	Омманей, 1932, стр. 327
16 Горбатый кит	Не более 30 мин.	Лиллн, 1910, ч. 3

Key to Table 21.[1]

a) Animal b) Time c) Author

1a) Platypus 1b) 10 min. 1c) Allport, 1878, pp. 30-31, Burell, 1927

2a) Sea Elephant 2b) 6 min. 48 sec. 2c) Harnisch 1937, pp.152-156, p. 225

3a) *Phoca* 3b) 15 min (more often 3-6 min.) 3c) Millais, 1906, V. I.

4a) Grey seal 4b) about 15 min. 4c) Millais 1906, V. I., p. 228

5a) Muskrat 5b) 12 min. 5c) Irving, 1939

6a) Beaver 6b) 15 min 6c) Irving et Orr, 1935, p.569

7a) Hippotamus 7b) 50 sec. 7c) Parker, 1932, p. 577

8a) Walrus 8b) 16 min. 20 sec. 8c) Parker, 1922, p. 127

9a) Sperm whale 9b) 1-1 1/4 hr. 9c) Millais, 1906, v.3 Scammon 1874, p.76
Beddard, 1900, p. 128

10a) Bottlenose whale 10b) 2 hrs. 10c) Gray, 1882, p. 276
(1 hr. wounded) Millais, 1906

11a) Bowhead whale 11b) 1 hr. 11c) Beddard, 1900, p. 128

12a) Blue whale 12b) 30 min. 12c) Allen, 1916, p. 193

13a) Pacific right whale 13b) 50 min. 13c) Andrews, 1916

14a) Large rorqual whale 14b) 30 min. 14c) Allen, 1916, p. 193

15a) Finback whale 15b) 20 min. 15c) Ommaney, 1932, p. 237

16a) Humpback whale 16b) not more than 30 min. 16c) Lillie, 1910, p.3

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[1] Trans. note: With regard to items 12, 14 and 15, *blyuval*, *bol'shoi polosatik*, *finval*, respectively, especially items 12 and 14, I find some confusion in the Russian common nomenclature. According to Ricker, the following seem to be used interchangeably: *blyuval* = *siniikit* = *bol'shoi polosatik* = *goluboi polosatik* = *sinii polosatik* "blue whale" (*Balaenoptera musculus*). With respect to item 15, *finval* = *sel'dyanoi kit*, presumably the author has in mind "finback whale", "fin whale", "rorqual" (*Balaenoptera physalus*). Since the author does not present the Latin nomenclature, going to the original source would be the best solution to this confusion.

As we can see, the bowhead whale, the sperm whale and the bottlenose whale particulary stand out in this respect, the duration of whose dives last from one to two hours, while the maximum duration of the dives of rodents (beaver, muskrat) and pinnipeds is determined as 15-16 minutes.

What should the lung capacity of cetaceans be? A. Krogh's (1934) *158 calculations in this respect are very interesting according to which it attains 14, 000 l in a blue whale weighing 122 tons. The oxygen reserve in its lungs is estimated by the figure 2800 l. This amount sustains the animal for 50 minutes of active swimming at a speed of 3 miles per hour.

In connection with the duration of diving, a very important question arises regarding the depth of the dive. It is quite obvious that for such a long period of the dive as is observed for example in the sperm whale or a bottle-nose whale, the animal is capable of descending to quite a consierable depth, a rapid ascent from which should have resulted in caisson disease. It consists in the fact that with an increased pressure, an additional amount of dissolved nitrogen forms in the tissues, which in a rapid change from an increased pressure to a normal one, is released from solution and forms bubbles (emboli) obstructing the blood vessels. Therefore, a controversy went on in the literature: some maintained that cetaceans are incapable of diving to a depth of more than 100 m since if the opposite was the case, then upon surfacing, an attack of caisson disease would inevitably have set in; others, on the other hand, maintained that a sperm whale, for example, dives to 1000 m.

N. Gregory's observations (1937), an account of which was given in our country by N. I. Tarasov (1938), established that sperm whales dive to depths of 510, 900 and 990 m. At this depth they discovered whales caught on an underwater cable with their jaws, Tarasov correctly noting (1938) that when a cable is laid, the depth is measured very accurately. Thus, these data raise no doubts.

What protects the animals from caisson disease? The fact that they actually do not suffer from caisson disease is evidenced by the studies of A. Laurie (1933) who established the absence of nitrogen supersaturation in the blood of animals caught after prolonged diving. Having discovered the presence of bacteria (x-bacteria) in the blood of whales which absorb nitrogen, Laurie considers that it is precisely these bacteria that protect the whales from caisson disease.

Krogh (1934) came out against this statement of Laurie's (1933), considering that it is impossible to attach to these bacteria the significance which Laurie imputes to them (1933) for two reasons. In the first place, the fixation of nitrogen by bacteria proceeds much too slowly for it to have any significance for the whale; in the second place, the process of such a fixation would have required twice as much oxygen as the whale itself requires.

It is difficult not to agree with Krogh's arguments, especially *159 since Laurie's conclusions were not confirmed by subsequent studies. We had already discussed in Chapter Two Scholander's (1940) point of view in this regard, who explains the absence of caisson disease in cetaceans by the features in the structure of the lungs. According to Scholander (1940), that as a result of the pressure during the dive, the air from the alveoli of the lungs enters the bronchioli and bronchi whose walls are reinforced with cartilaginous tissue due to which they resist the pressure. This impedes the entry of nitrogen into the blood in amounts dangerous to the animal, which is what protects the cetaceans against caisson disease.

However, the statement of the question itself regarding the possibility of caisson disease in cetaceans and the search for special adaptations in them against this disease, as I. S. Kandrov (1941) notes, might be wrong. For the point is that the whale does not breathe compressed air, but taking into its lungs a reserve of atmospheric air, retreats into the water, the total amount of nitrogen in the lungs of the whale, as the author points out, in all exceeding the nitrogen capacity in the tissues only by 3-4 times. The pressure in the hermetically sealed pulmonary space in the whale by virtue of the resistance of the surrounding pressure of the respiratory muscles can hardly exceed 4 atmospheres, and such a pressure, as experience from diving studies has shown, is not even dangerous for man. One also has to take into consideration the low velocity of blood flow in the whale. "Therefore," concludes Kandrov (1941, p. 121), "it is necessary to assume that the possibility of diseases of the nature of caisson disease in cetaceans is completely excluded".

The next remarkable feature of respiration in diving animals is their insensitivity to the accumulation of carbon dioxide in the organism. While for all terrestial animals the stimulus for the act of breathing is not a deficit of oxygen, but namely an accumulation of carbon dioxide, diving animals, a fact which was established by Irving's studies (1936, 1937, 1938, 1938a), do not respond to an inspiration of air containing a large amount of carbon dioxide. Thus, as J. Comrie and C. Schmidt (1938) point out, the regulator of respiration in diving animals is a deficit of oxygen in the organism, and not the accumulation of carbon dioxide as in terrestial animals.

Such an insensitivity of the respiratory center of the animals to carbon dioxide in the organsm allows them to utilize the oxygen reserve to to the absolute maximum. What then are the proportions of these reserves in diving animals?

The oxygen capacity of the blood of these animals is not much higher than in man and terrestial animals. In any case, it is clear that it (the blood-Trans.) alone could not have provided for such a long period of apnea which is evident from Table 22 that I borrowed from Irving (1939, p. 119), and which Kreps (1941, p. 46) also presents.

Table 22

Oxygen capacity of blood

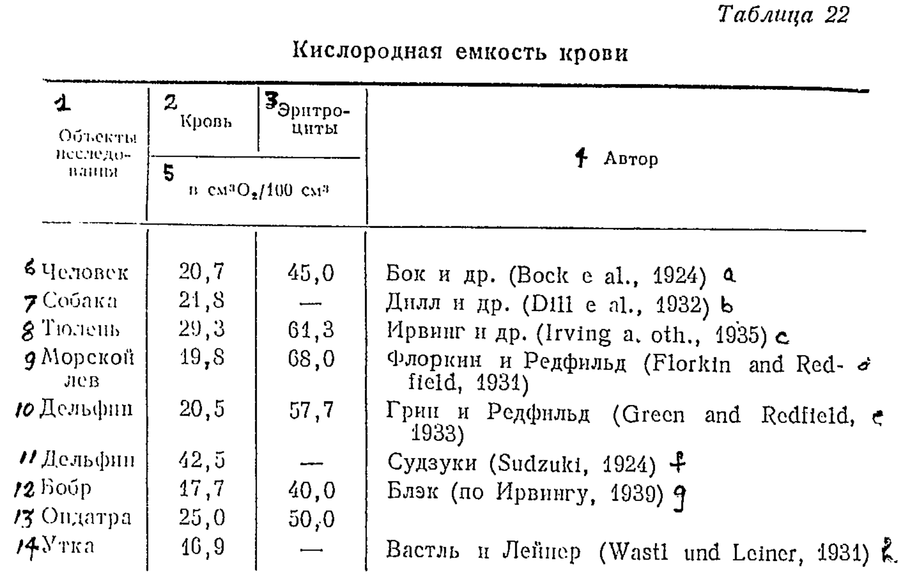

Таблица 22

Кислородная емкость крови

1 Объекты исследования	2 Кровь	3 Эритроциты	4 Автор
	5 в см³O₂/100 см³		
6 Человек	20,7	45,0	Бок и др. (Bock e al., 1924) a
7 Собака	21,8	—	Дилл и др. (Dill e al., 1932) b
8 Тюлень	29,3	61,3	Ирвинг и др. (Irving a. oth., 1935) c
9 Морской лев	19,8	68,0	Флоркин и Редфильд (Florkin and Redfield, 1931) d
10 Дельфин	20,5	57,7	Грин и Редфильд (Green and Redfield, 1933) e
11 Дельфин	42,5	—	Судзуки (Sudzuki, 1924) f
12 Бобр	17,7	40,0	Блэк (по Ирвингу, 1939) g
13 Ондатра	25,0	50,0	
14 Утка	16,9	—	Вастль и Лейнер (Wastl und Leiner, 1931) h

Key to Table 22:

1) Subjects of study 2) Blood 3) Erythrocytes 4) Author

5) in cm^3 O$_2$/100 cm^3 4g) Black E.C. (according to Irving, 1939)

6) Man 7) Dog 8) Seal 9) Sea lion 10) Dolphin 11) Dolphin 12) Beaver

13) Muskrat 14) Duck.

The volume of blood, according to the data in the literature, in diving animals as compared with terrestial animals is also small. Thus, for example, I. V. Govorkov (1934) establishes the amount of blood in the beluga as 5 % of the weight of the animal. Tomilin (1947) quotes the same figure for the Black Sea common dolphin; Laurie reports a figure of 6.5 % for the blue whale; Irving (1938a) quotes an average of about 10 % for the beaver and seal.

On the basis of experience of studies on beluga, Caspian seal and Black Sea dolphin catches, I am of the opinion that these figures, especially those of Govorkov, Tomilin and Laurie, are too low. However, I personally was not involved in the determination of the amount of blood. Unfortunately, Korzhuev and Bulatova (1951, 1952) did not do this either.

A completely different picture is observed in the amount of muscle hemoglobin. Here in diving animals there is a clear and considerable superiority.

If Whipple's (1926) and Irving's (1936) information on man and Robinson's (1936) on the seal are compared, as Johnson, Forbes, Dill and Henderson (1940, p. 33) have done, then the following data will be observed (Table 23). *161

Table 23

Oxygen reserve (in ml)

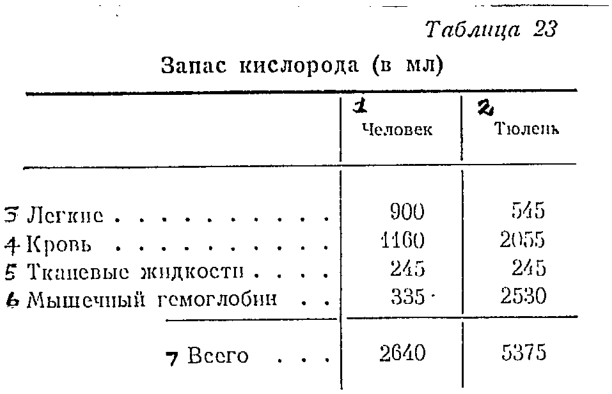

Таблица 23

Запас кислорода (в мл)

	1 Человек	2 Тюлень
3 Легкие	900	545
4 Кровь	1160	2055
5 Тканевые жидкости	245	245
6 Мышечный гемоглобин . .	335	2530
7 Всего . . .	2640	5375

Key to Table 23.

1) Man 2) Seal 3) Lungs 4) Blood 5) Tissue fluid 6) Muscle hemoglobin 7) Total

---

Of prime importance in the binding of oxygen, as can be seen from Table 23, is the muscle hemoglobin and of least importance - the blood, which gives the seal enormous overall superiority even despite the smaller lung volume.

One should add to that the fact that 5 years before the appearance of Robinson's (1939) work, G. Theorell (1934) had discovered a large amount of hemoglobin in the cardiac muscles of the seal, explaining by this fact the seal's capacity for prolonged dives.

On the basis of Irving's (1935a) and others' data regarding the fact that the gas exchange in the seal is 370 cm^3 of oxygen per minute, Robinson (1939) calculated that the reserve of oxygen in the organism of the animal can sustain it for 14.5 minutes.

Taking into consideration Korzhuev's data (1949) on the high affinity of the muscular hemoglobin for oxygen and that it "combines with oxygen several times (3-6) as fast as the hemoglobin of the blood" (p. 85), and also the greater muscle mass in cetaceans, it is possible to comprehend what a large reserve of oxygen the muscles of these animals carry. It is not without reason then that Scholander (1940) notes that in the best divers - the sperm whale and the bottle-nose whale - the amount of muscle hemoglobin is so great that upon contact with the air in the atmosphere the muscles of these animals become almost black. On the whole though, it should be noted that in all diving animals the color of the muscles compared with those of terrestial animals strikes one with their dark color.

A certain additional amount of oxygen is contained in the subcutaneous layer of fat as well, although Irving's calculations show that these amounts are not great and could not increase significantly the duration of the animal's dive. *162

The physiological characteristics of diving animals are muscle relaxation and a simultaneous decrease in the number of heart contrations during submersion in the water. This fact was already noted by P. Bert (1870) in the duck, D. Paton (1927) in the swan, T. Koppanyi and M. Dooley (1929) in the muskrat, Irving and Orr (1935) in the beaver, and Irving (1937) in the beaver and muskrat.

It can be assumed that this leads to a decrease in the expenditure of energy and consequently to a reduction in the consumption of oxygen.

There are no such observations for the Cetacea. Taking into consideration the large amount of muscle hemoglobin that they have, it can be assumed that it provides oxygen for the work of the muscles of the animal for the duration of the dive even without their relaxation.

A remarkable adaptation in the structure of the circulatory system of the diving animals is the so-called rete mirabile system. The rete mirabile is known to terrestial mammals as well, but in cetaceans, judging by the descriptions of Howell (1930), Ommaney (1932), Krogh (1934), Scholander (1940) and others, it is highly intensely developed.

Being a vascular network formed from the arteries and veins, the rete mirabile in cetaceans is distributed from the base of the skull along the thoracic cage.

There are some data on the development of the rete mirabile, the carotid and the vertebral arteries in the Black Sea common dolphin in the works of E. S. Yakovleva (1951, 1951a).

The function and the physiological significance of the rete mirabile in the cetaceans is as yet unclear; nevertheless, one can agree with Ommaney's opinion (1932) that this formation facilities a prolonged dive in these animals. Thus, Irving (1939) ascribes great significance to the vascular reflexes established in the animals, during diving. During a period of apnea, the blood vessels supplying the muscles become constricted, as a result of which, the supply of blood to the muscles is decreased and the supply to central nervous system which responds most sharply to oxygen starvation, increases. Therefore, Scholander (1940) considers that during diving, circulation in the cetaceans occurs mainly through the rete mirabile which shortens significantly the circulatory circuit, and consequently, allows for a more economical expenditure of the oxygen reserve in the blood which at this time supplies mainly the brain.

This hypothesis ties in nicely with available data on the decrease in the number and intensity of cardiac contractions during diving. As a result, the rete mirabile allows not only for a more economical expenditure *163 of oxygen reserves in the blood, but eases the work load on the heart during prolonged apnea as well.

Bearing in mind the large amount of muscle hemoglobin in diving animals, one can assume that the work of the muscles during the dive is sustained by their own reserves of oxygen while all the oxygen in the blood is consumed mainly by the central nervous system.

Having examined very superficially and of course, far from completely the physiological characteristics of the respiration in diving animals, it is possible to enumerate them briefly. In comparison with terrestial animals they are:

1) a larger lung capacity (see data on number of alveoli in the lungs of dolphins in the second chapter);

2) a somewhat greater oxygen capacity of the blood;

3) an insensitivity of the respiratory center to an accumulation in the organism of carbon dioxide, which allows for an almost compete utilization of the oxygen reserves;

4) a greater amount of muscle hemoglobin, sustaining the work of the muscles with oxygen;

5) vascular reflexes, decreasing the blood supply of the muscles and increasing the blood supply of the brain during periods of apnea;

6) an intensive development of the rete mirabile which allows for a more economical consumption of oxygen and an easing of the work load of the heart during diving.

In conclusion, we will note that the most reliable figures in the area of the physiology of respiration in diving animals were obtained on rodents and pinnipeds. For the cetaceans, which at the present time are of most interest, there are already considerably fewer data, and here the physiology often crosses into the realm of hypothesis. This is explained by the fact that up until now attempts at similar studies were done on whales. This subject is difficult not only because of its dimensions, but also by the fact that by virtue of the conditions of the industry the researcher gets a dead or at best of times, a dying animal. Besides, in our country in the dolphin catching operations the animals (due to the operations) can be delivered on shore not only alive, but absolutely unharmed. It is precisely here that the most delicate physiological experiments of any kind could be conducted; the small dimensions of the animals contributing to them as well.

Let us turn to the data regarding the blood of our dolphins. In order to characterize the erythrocytes of the dolphins we will take advantage of Korzhuev and Bulatova's data (1952) on the basis of which they formulate the conclusion regarding the greater saturation of dolphin blood with hemo- *164
globin in comparison with the erythrocytes of terrestial mammals (Table 24).

Table 24

Comparative data characterizing the erythrocytes of the dolphins, certain terrestial mammals and man.[1]

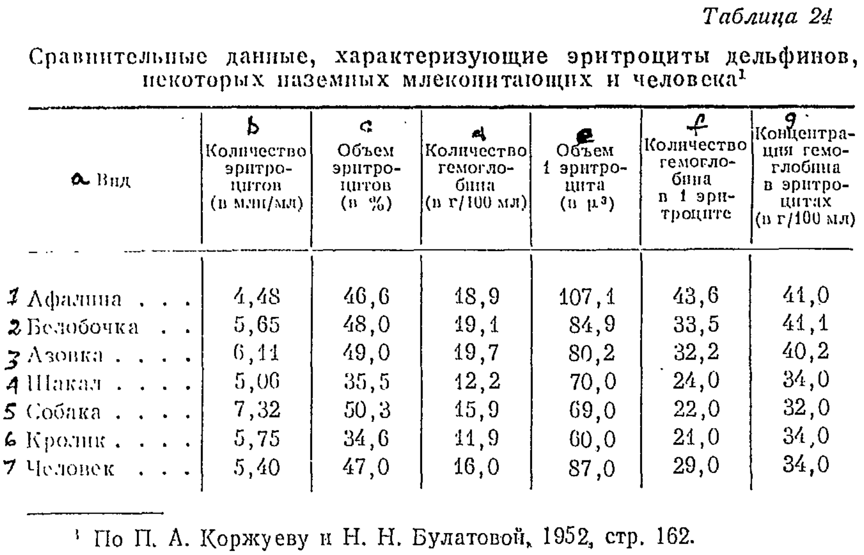

Таблица 24

Сравнительные данные, характеризующие эритроциты дельфинов, некоторых наземных млекопитающих и человека[1]

a Вид	b Количество эритроцитов (в млн/мл)	c Объем эритроцитов (в %)	d Количество гемоглобина (в г/100 мл)	e Объем 1 эритроцита (в μ³)	f Количество гемоглобина в 1 эритроците	g Концентрация гемоглобина в эритроцитах (в г/100 мл)
1 Афалина . . .	4,48	46,6	18,9	107,1	43,6	41,0
2 Белобочка . .	5,65	48,0	19,1	84,9	33,5	41,1
3 Азовка	6,11	49,0	19,7	80,2	32,2	40,2
4 Шакал	5,06	35,5	12,2	70,0	24,0	34,0
5 Собака	7,32	50,3	15,9	69,0	22,0	32,0
6 Кролик	5,75	34,6	11,9	60,0	21,0	34,0
7 Человек . . .	5,40	47,0	16,0	87,0	29,0	34,0

[1] По П. А. Коржуеву и Н. Н. Булатовой, 1952, стр. 162.

Key to Table 24:

a) Species b) Number of erythrocytes (in millions/ml) c) Volume of erythrocytes (in %) d) Amount of hemoglobin (in g/100 ml) e) Size of a single erythrocyte (in μ^3) f) Amount of hemoglobin in a single erythrocyte g) Concentration of hemoglobin in the erythrocytes (in g/100 ml).

1) Bottlenose 2) Common dolphin 3) Harbour porpoise 4) Jackal 5) Dog 6) Rabbit 7) Man

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[1] By P. A. Korzhuev and N. N. Bulatova, 1952, p. 162.

Since Korzhuev and Bulatova's (1952) data on the Azov dolphin are based on the study of only a single specimen and the gas exchange in this species was not studied by us, then we will compare only the data concerning the common dolphin and the bottlenose.

From Table 24, it is evident that the bottlenose, in comparison with the common dolphin, has erythrocytes that are larger and contain a greater amount of hemoglobin, but there are fewer erythrocytes in the blood of the bottlenose than in the blood of the common dolphin. On account of this, the concentration of hemoglobin in the erythrocytes (g/100 ml) in both species is the same. Thus, the result is that no advantages in the oxygen capacity of the blood of the bottlenose are revealed with the blood of the common dolphin. They do not report any data on the blood plasma and other body fluids. Moreover, while studying the blood it would have been extremely important to undertake the determination in the various species of the volume of blood in the organism, the velocity of blood flow, the blood pressure, and to attempt to reveal the function of the rete mirabile.

In light of Robinson's (1939) (see Table 23) and Scholander's (1940) data on the seal and cetaceans, it would have been necessary to deal with this hemoglobin in the dolphins as well since it is quite probable that it is precisely here that a discovery of differences in the various species would have been successful.

Korzhuev and Bulatova (1951) report some very interesting data regarding the blood of the common dolphin embryos. It turns out that in the embryos the concentration of hemoglobin in the erythrocytes and the oxygen capacity of the blood is considerably higher than in adult animals. The authors explain this "as a manifestation of a unique adaptation to unfavor- *165 able conditions of embryonal development in cetaceans when the external respiration of the mother is systematically shut off, at times for long periods" (p. 116).

In light of this phenomenon, the fact that Korzhuev and Bulatova (1952) discovered a somewhat higher number of erythrocytes and a higher hemoglobin content in the blood of common dolphin and bottlenose males as compared with females, takes on great interest. Unfortunately, the authors do not note what kind of females they were dealing with. If these were pregnant and recently parous females, then the disproportion in the number of formed elements of the blood in the females in comparison with the males, one would think, should have been even greater. If, on the other hand, the authors had at their disposal non-parous and barren females, then one would think that the result should have been a different one. Such a rather vieled over result in the sex differences of the blood of the dolphins was obtained by the authors apparently on account of the absence of differentiation of the materials on the females. Moreover, the time of year when the hematological studies were being conducted allowed to the fullest the possibility of collecting any amount of material on the common dolphin females which were in the most diverse biological states, i.e. on the sexually immature, the pregnant, the recently parous, the parous and the barren.

Thus, the very interesting studies of Korzhuev and Bulatova (1951, 1952) can be considered for the present as only the first stage, not having revealed the physiological adaptations inherent in the various species of dolphin.

Proof of the existence of such adaptations is established by data on both the ecology of the animals as well as the morphology and gas exchange, to the examination of which we will turn in the following section.

2. MORPHOLOGICAL AND PHYSIOLOGICAL CHARACTERISTICS OF THE DOLPHINS

In the external appearance of the dolphin that inhabit the Black and Azov Seas, one's attention is drawn first of all to the differences in the body dimensions of the individual species. The smallest dolphin is the harbour porpoise, and the largest, the bottlenose. The common dolphin occupies an intermediate position.

To illustrate the differences in the size of the body, I am presenting Table 25 where the minimum dimensions correspond to the dimensions of newly-born individuals.

Table 25

Body dimensions of the dolphin inhabiting the Black and Azov Sea (in cm).

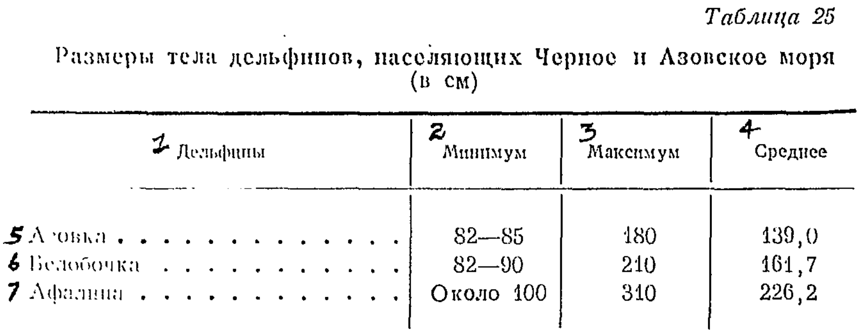

Таблица 25

Размеры тела дельфинов, населяющих Черное и Азовское моря (в см)

1 Дельфины	2 Минимум	3 Максимум	4 Среднее
5 Азовка	82—85	180	139,0
6 Белобочка	82—90	210	161,7
7 Афалина	Около 100	310	226,2

Key to Table 25:

1) Dolphins 2) Minimum 3) Maximum 4) Mean 5) Harbour porpoise 6) Common dolphin 7) Bottlenose

---

The proportions of the body dimensions in the males and females of *166
the various species are also different.

In the bottlenose and in the common dolphin, the males are larger than the females. In the harbour porpoise, on the contrary, the females are larger than the males (see Chapter I).

Sharp differences in the shape of the head, mainly the rostral section, are observed among the individual species. In the harbour porpoise the snout is not elongated and is blunt, for which reason it is even called blunt-snouted by some authors. In the bottlenose, the snout is elongated, but to a lesser degree than in the common dolphin in which an extremely elongated and comparatively thin snout projects forward, which brought about its name - the sharp-snouted dolphin.

I will not dwell here on the differences in the skull proportions since the skull proportions of all three species were examined in detail in the first Chapter and a table is given in the Appendix.

The number, size and shape of the teeth in the various species vary intensely, the number of teeth being particularly variable. Apparently this is what explains the fact that different authors indicate a different number of teeth for the same species. Thus, for example, Silant'ev (1903) and Mal'm (1932) indicate that in the common dolphin the number of teeth amount to 240, which evidently is incorrect since none of the subsequent researchers found this number of teeth in this species. Tryuber (1939) establishes the maximum number of teeth in the common dolphin as 204, and Barabash-Nikiforov (1940) - 206. I have counted up to 190 teeth in this dolphin.

In spite of the fluctuations in the amount of teeth, their number is nevertheless representative of every species. Also different is the frequency of the teeth and their size. I illustrate this aspect in Table 26 on the basis of original data and data from the literature.

As we can see, the common dolphin has the greatest number of teeth and the bottlenose, the fewest, in which the frequency of teeth is half of that of the other species. The bottlenose has the largest teeth and *167 the harbour porpoise has the smallest.

Table 26

Number, frequency and size of teeth in the dolphins of the Black and Azov seas.

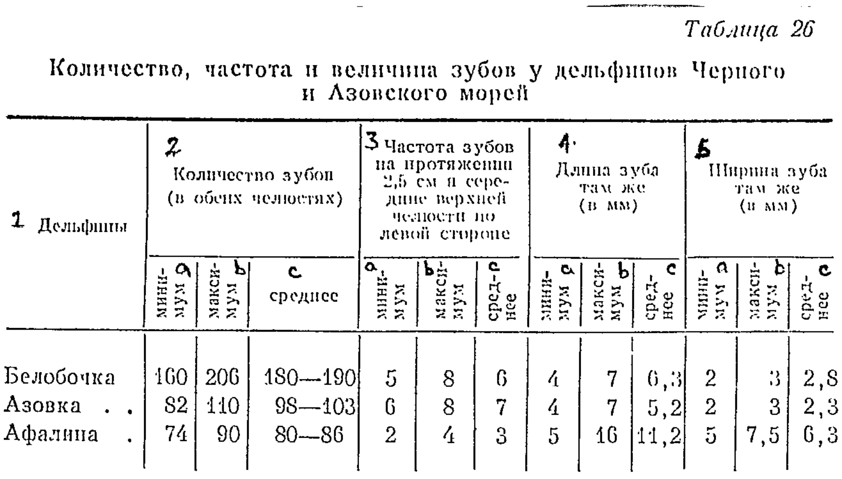

Таблица 26

Количество, частота и величина зубов у дельфинов Черного и Азовского морей

1 Дельфины	2 Количество зубов (в обеих челюстях)			3 Частота зубов на протяжении 2,5 см в середине верхней челюсти по левой стороне			4 Длина зуба там же (в мм)			5 Ширина зуба там же (в мм)		
	минимум a	максимум b	c среднее	a минимум	b максимум	среднее c	минимум a	максимум b	среднее c	минимум a	максимум b	среднее c
6 Белобочка	160	206	180—190	5	8	6	4	7	6,3	2	3	2,8
7 Азовка . .	82	110	98—103	6	8	7	4	7	5,2	2	3	2,3
8 Афалина .	74	90	80—86	2	4	3	5	16	11,2	5	7,5	6,3

Key to Table 26:

1) Dolphins 2) Number of teeth (in both jaws) 3) Frequency of teeth in a 2.5 cm span in the middle of the maxilla on the left side.

4) Length of tooth in the same area (in mm)

5) Width " " " " " " " " 6) Common dolphin

7) Harbour porpoise 8) Bottle-nose dolphin a) Minimum b) Maximum c) Mean

---

In the common dolphin the greatest number appear in both the upper and lower jaws. In the bottlenose and the harbour porpoise, the greatest number of teeth always occur only in the maxilla. In this respect, Slijper's (1938) indication that in the harbour porpoise the number of teeth in both jaws is the same has to be considered as incorrect.

The shape of the teeth is also different: in the common dolphin they are thin, conical and very sharp; in the bottlenose, they are also conical but thick and non-sharp; in the harbour porpoise, the conical teeth occur on the anterior tips of the jaws. Further, in a direction from front to back, the teeth become larger; a distinct neck separates the crown from the root and the crown is "lamellar" in nature. I am not touching upon the variations in the shapes of the teeth in this species, a topic which was already discussed in the first Chapter. A description of the differences in the shape and size of the teeth is illustrated in Fig. 44.

One should mention yet another fact which is not without interest. In the common dolphin and the harbour porpoise, the teeth are never worn down while in the bottlenose, the teeth situated near the anterior tips and in the middle of the jaws are often worn so badly that they never rise above the level of the jaws (Fig. 45). This situation is directly related to the feeding of the animals. As was noted in the preceding chapter, the common dolphin and the harbour porpoise feed exclusively on small fish while the bottlenose devours large fish as well, which apparently it seizes with its teeth: hence the reason for their being worn down.

One's attention is drawn to the external morphology of the blowhole.

It is customary to consider that in the toothed cetaceans in contrast to the baleen whales, there is one external air passage. In the cranium *168 there are two. Nevertheless, in the common dolphin and the harbour porpoise the external air passage is a single opening. In the bottlenose, on the other hand, over the osseous septum yet another septum of cartilage and connective tissue is formed, reaching almost to the very external valve. As a result of this, the blowhole immediately below the valve is divided by a vertical septum into two sections which hampered extremely the gas exchange studies in this species, since it was only possible to insert the tee into the blowhole to a most negligible depth.

The dorsal fin is a feature by which it is very easy to distinguish the animals in the sea. It is also distinct according to shape. In the harbour porpoise it is comparatively low, almost triangular. In the common dolphin and the bottlenose, it is high, pointed and bent backward into the shape of a crescent - to a greater degree in the bottlenose than in the common dolphin.

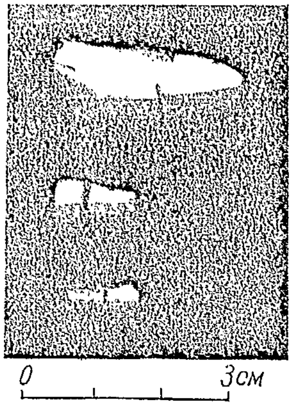

Рис. 44. Форма и величина зубов афалины (сверху), белобочки (по середине) и азовки (снизу) (оригин.).

Fig. 44. Shape and size of the teeth in the bottlenose (above), the common dolphin (center), and the harbour porpoise (below) (origin.).

Finally, let us note the differences in the coloration of the animals disregarding those variations which were discussed in the first Chapter. The bottlenose and the harbour porpoise are similar according to the pattern of coloration. The back and the flanks of these dolphin have a monochromatic grey color with a steel hue, with variations ranging from intensely dark, almost black to a light grey. The abdomen is pure white or a light grey.

The coloration of the common dolphin differs sharply from the one described. One is struck first of all by the very unique pattern in the coloration of the flanks of the body of the dolphin created by a combination of alternations of fields and bands of various shades; from a pure white to a dark grey, to almost black. The abdomen is always of a pure white color. The coloration of the animal completely justifies its name; the white-sided dolphin, or belobochka .

The specific traits in the external appearance noted above in the dolphins which inhabit the Black and Azov Seas are quite noticeable in Figures 14, 18, 20, 46.

We have yet to dwell on albinism in the Azov dolphin, peculiar apparently only to this species.

Total albinism in animals in nature is generally a rare phenomenon. Partial albinism, i.e. depigmentation of certain areas of the surface of the body occurs more often.

The most widely distributed form of partial and total albinism in terrestial mammals and birds is one in which a depigmentation of the hair cover and plumage occurs. In animals without hair or plumage, cases of albinism are very rare. *169

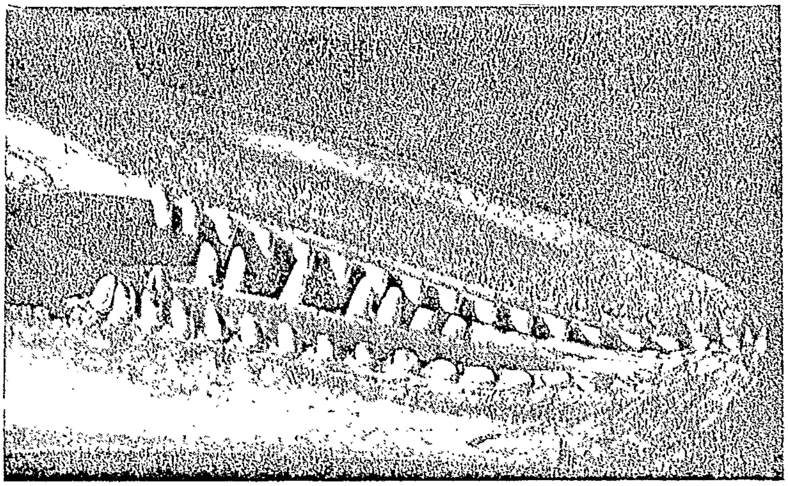

Рис. 45. Стертость зубов, встречающаяся у афалины (оригин.).

Fig. 45. Wearing down of teeth occurring in the bottle-nose dolphin (origin.).

There are a few known cases of anomalies in the pigmentation of the skin in the so-called goldfish. Besides that, C. Kosswig (1935) described two cases of partial albinism with depigmentation of the eyes in Macropodus viridi auratus Lacepede and Xiphophorus helleri Heckel.

W. Schreitmüller (1934, 1934a) presented two cases of pigmentation anomalies in fish: melanism in Nemachilus barbatus (1934), the author indicating also that several years previously he had occasion to see a partial albino in this same species and total albinism in Xiphophorus helleri Heckel (1934a).

With respect to albinism in the cetaceans, there are few indications in the literature.

I will not concern myself here with descriptions existing in the literature of doubtful cases of albinism in cetaceans whose species were not specified. E. Prince (1913) wrote about a case of partial albinism in a harbour porpoise caught near the coast of Scotland. The specimen he described was a sexually immature female 90 cm long.

P. Peters (1929) gave a more complete description of albinism in the harbour porpoise. The case he described concerned a large male, 150 cm long, caught in July of 1929 in the Skagerrak. *170

The pigmentation of this specimen was unique. Its body was pure white in color. The pigment was preserved only on the lips from their external edges to the tooth rows. Next, in the form of a large spot on the forehead extending to the occiput of the animal in a thin stripe running along the crest. This band, reaching the dorsal fin, bifurcated and encircled the latter and stopped behind it. The pigment was also preserved on the upper corner of the dorsal fin and in the form of a few small spots on the caudal fin. The eyes were pigmented. Thus, this specimen was a typical partial albino, retaining a small amount of pigment on the head, dorsal and caudal fins.

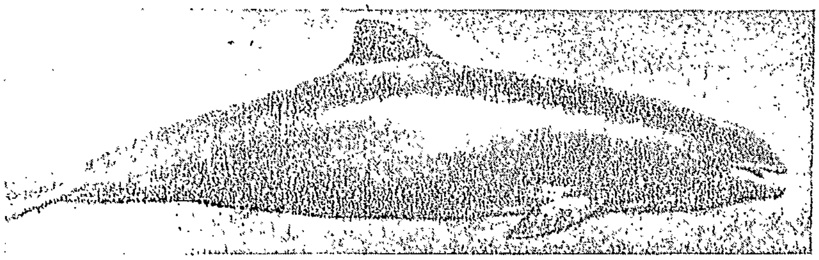

Рис. 46. Азовский дельфин (по В. И. Цалкину).

Fig. 46. An Azov dolphin (by V. I. Tsalkin).

Of the Black Sea dolphin, I described (1936a) an almost total harbour porpoise albino caught in April of 1928 in the region between Balaclava and Yalta from a photograph by E. E. Boyko so kindly passed on to me by the late V. Yu. Marti.

Although the pigment in this specimen was preserved to a considerably lesser degree than in the specimen described by Peterson (1929), it was located on the same areas of the body. The entire body of our albino was of a pure white color. The eyes were pigmented. The pigment was preserved on the lips and in the form of a narrow, longitudinal stripe on the forehead, and then in the shape of a crescent on the head directly behind the blowhole, in a solid mass like a hood on the upper section of the dorsal fin, and in the form of small spots on its posterior section, and in the upper section of the caudal fin (Fig. 47). The dark spots on the flanks of the body of the animal are not pigment but wounds and blood.

Mal'm (1933), describing the Black Sea dolphins, also writes that "the phenomenon of albinism occurs in the dolphins. Thus, in 1928, a completely white <u>Delphinus</u> <u>delphis</u> was killed near Balaclava. Apparently this *171
phenomenon is rare" (p. 38).

Taking into consideration the identity of the region and the year of acquisition of the specimen indicated by Mal'm (1933) with the region and year of acquisition of the specimen that I described, I proposed (1936a) that Mal'm cited this report on the basis of someone else's word and an incorrect identification of the species of the animal, and that consequently his report should not be taken as relating to a common dolphin but to the harbour porpoise specimen described by me. Moreover, I had also noted at the time that albinism is apparently more characteristic of harbour porpoises than of the other species of dolphin.

Subsequent data only confirmed my opinion. Thus, Tsalkin (1938) described a partial harbour porpoise albino as well, caught in 1937 in the Yalta region. This was a large male 146 cm long. Figure 48 gives an idea of the nature of its coloration compared with an individual of normal pigmentation.

Finally, in the summer of 1948 in the Novorossiisk region on information from the director of the Novorossiisk Biological Station, E. I. Drakin, two albino harbour porpoises (a male and female) were discovered in a single school of dolphin caught with a single set of a seine net. It is interesting that on the Black Sea where at least fifty times as many common dolphin as harbour porpoises have gone through the hands of researchers, nonetheless, not a single reliable case of albinism in the common dolphin was recorded while four cases have been described for the harbour porpoise.

As a result, it can now be not assumed, but affirmed that within the dolphins albinism is peculiar only to Phocaena phocaena.

It is impossible to explain this situation at the present time since neither the phenomenon of albinism itself, nor the causes underlying it, have hitherto been studied.

Let us turn to the constitutional and physiological characteristics *172 of our dolphins.

The first thing to attract one's attention and which ties in nicely with the differences in the ecology of the animals, is the different length in the respiratory pause.

The benthonic bottlenose which dives to great depths is capable of the longest period of apnea as well. In the other benthonic species which does not dive as deeply as the bottlenose, namely the harbour porpoise, the respiratory pause is considerably shorter. And finally, the shortest respiratory pause occurs in the pelagic common dolphin. The above indicated is corroborated by the data of Table 27.

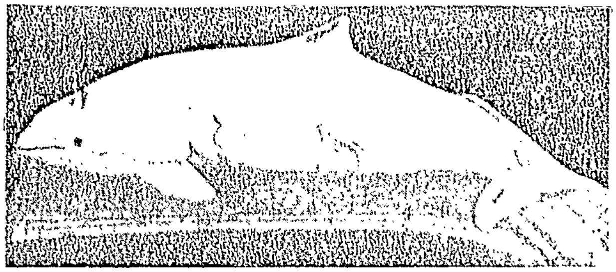

Рис. 47. Альбинос азовки (по С. Е. Клейненбергу).

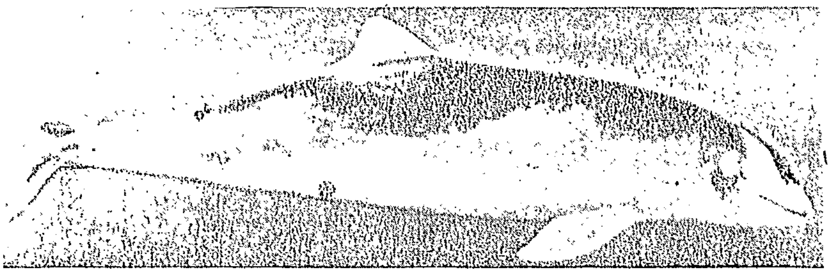

Рис. 48. Альбинос азовки (по В. И. Цалкину).

Fig. 47. A bottlenose albino (by S. E. Kleinenberg).

Fig. 48. A harbour porpoise albino (by. V. I. Tsalkin)

Table 27

The duration of the respiratory pause in the various species of dolphin.

Таблица 27

Продолжительность дыхательной паузы различных видов дельфинов

1 Дельфины	2 Продолжительность дыхательной паузы (в минутах)
3 Белобочка	1,5—3,0
4 Азовка	4—6[1]
5 Афалина	13—15

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[1] По П. Шоландеру (1940) достигает даже 12 минут.

Key to Table 27:

1) Dolphins 2) Duration of the respiratory pause (in minutes)

3) Common dolphin 4) Harbour porpoise 5) Bottlenose

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[1] According to Scholander (1940), even goes as high as 12 minutes.

In order to show how the constitution of the animals corresponds to the differences in the duration of the respiratory pause, I am presenting Table 28 where the indices of the internal organs, as well as in the succeeding tables, are expressed in the number of grams per 1 kg of live weight of the animal, i.e. in parts per thousand.

As I have already note (1952), despite the differences in the size of the animals the indices of their internal organs are generally close. The differences within the individual species correspond fully with their ecological features. This emerges most distinctly in the index of the lungs. The pelagic common dolphin has the smallest lungs. In the benthophagous bottlenose requiring large reserves of oxygen, the relative size of the lungs is the greatest. Compared with the common dolphin, the difference here is 3.5 gm for every kilogram of live weight of the animal. And finally, in the benthophagous harbour porpoise, but one which does not dive to great depths, the lung index falls in between the two.

Table 28 *173

Indices of the internal organs of the dolphin.

Таблица 28

Индексы внутренних органов дельфинов

1 Дельфины	2 Длина (в см)	3 Вес (в кг)	4 Индекс					
			a легких	b сердца	c почек	d печени	e селезенки	n
5 Белобочка	161,1	54,2	19,00	4,84	5,44	18,23	0,80	50
6 Азовка	125,0	28,5	21,23	4,52	5,34	21,25	0,13	50
7 Афалина	212,2	132,8	22,56	5,00	6,42	20,16	0,66	50

<u>Key to Table 28</u>:

1) Dolphins 2) Length (in cm) 3) Weight (in kg) 4) Index

4a) Of the lungs 4b) the heart 4c) the kidneys 4d) the liver

4e) the spleen 5) The common dolphin 6) Harbour porpoise

7) The bottlenose

The bottlenose also has the largest heart. In this respect, the harbour porpoise is inferior to the common dolphin which is evidently related to its slowness of movement in comparison with the very rapidly swimming common dolphin. The same picture is observed with respect to the kidneys as well. Only the liver in the harbour porpoise is the largest, which is perhaps connected with the constant and very insignificant size of its pancreas.

It is interesting to compare the indices of the same organs of a wolf (Canis lupus) and the Ladoga seal (Phoca hispida ladogensis), so kindly passed on to me by A. S. Sokolov (Table 29), with the data on the indices of the internal organs of the dolphin presented above.

Table 29

Indices of the internal organs of a wolf and a Ladoga seal.

Таблица 29

Индексы внутренних органов волка и ладожского тюленя

1 Животное	2 Длина (в см)	3 Вес (в кг)	4 Индекс				
			a легких	b сердца	c. почек	d. печени	n
5 Волк	116,8	31,8	12,0	8,9	6,2	24,2	40
6 Ладожский тюлень . .	104,6	30,2	27,4	7,2	6,4	27,2	20

Key to Table 29:

1) Animal 2) Length (in cm) 3) Weight (in kg) 4) Index

4a) Lungs 4b) Heart 4c) Kidneys 4d) Liver 5) Wolf 6) Ladoga Seal

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In comparing Tables 28 and 29, it can be noted that in the Ladoga seal all of the indices, except for the index of the kidneys, is considerably higher than in our dolphins. One's attention is drawn to the extent to which the index of the lungs in all acquatic animals, especially in the diving animals, is higher than in the wolf. But then the heart index in the latter is considerably higher; in the seal it falls somewhere in between the wolf and the dolphin. I would mention that in all cetaceans (both toothed as well as the whalebone) the heart index is characterized by a figure in the order of five. A continuous acquatic way of life clearly re- *174 duces the relative size of the animal's heart.

It should be noted that in the comparison of indices, I took not only the same number of animals of the various species with a similar age-sex composition, but during the same time of the year. Observing these conditions is of key importance as will be seen from later discussions.

In spite of the fairly large number of studies on the weighing of various organs of animals, only I. K. Tarnani (1928) emphasizes the necessity of observing these conditions.

Data on the weighing of the individual organs in the Black Sea dolphins are contained in a thorough investigation by Ts. V. Okuneva (1934) and in a study by A. M. Dragunov and N. E. Kasinova (1951); the works of Zenkovich (1937), I. I. Kharkov (1940), Tomilin (1947) and others, contain such materials on whales.

R. Hesse (1921) published a large amount of data on the heart index of the representatives of all the classes of vertebrates and showed that the relative weight of the heart varies highly even in close forms, and that with an increase in the size of the animal the heart index decreases. The author comes to the conclusion that the mobility of the animal and its latitudinal place of habitation influences the size of the heart.

A. A. Mashkovtsev (1935) was determining the indices of the heart, spleen, liver and kidneys in certain animals from the mountain regions of Abkhazia. Explaining the influence of a mountain climate on the size of the heart and comparing this material with the data for the same species presented by Hesse (1921), he came to the conclusion that a mountain climate causes an enlargement of the heart.

V. A. Popov (1951) used a morphological method (which he calls "anatomical") in an analysis of the ecology of animals.

Finally, a large amount of data on the weighing of the various organs of animals, particularly in the cetaceans, are contained in the works of H. Welcker and A. Brand (1902), B. Rensch (1948) and K. Wirz (1950).

Thus, we see that the application of a morphological method in ecology is beginning to attract the attention of researchers. On the other hand, the use of weight indices as morpho-ecological indicators is, of course, extremely tempting. *175

Nevertheless it is necessary to emphasize here that besides accuracy in the methodological procedures (which was already discussed in the introduction) in comparing the indices in the various species or populations of animals, it is absolutely indispensible to observe the principle of uniformity of the material being compared as regards the age and sex of the subject and the biological season of the year. I will attempt to demonstrate the necessity of this later on the basis of our material.

Unfortunately, this principle of uniformity of the material is not always observed; for example, in the works of Hesse (1921) and Mashkovtsev (1935), it is simply ignored, not to mention the fact that the indices are sometimes computed on such a negligibly small number of specimens that they cannot, of course, characterize the average index for a given population.

In Table 30, where the indices of the internal organs of embryos in the final stage of embryonal development, underyearlings, yearlings and of older age groups of the common dolphin are presented, it is shown how the indices within the very same species change depending on the age of the animal.

From this Table it is evident, in the first place, that the indices here are considerably greater than the interspecific differences (see Table

28); and in the second place, an inverse relationship between the size of the animal and the relative dimensions of its internal organs is observed within a single species.

Table 30

Indices of internal organs of common dolphins of various ages.

Таблица 30

Индексы внутренних органов белобочек различного возраста

1 Возраст	2 Длина (в см)	3 Вес (в кг)	4 Индекс					
			a легких	b сердца	c почек	d печени	e селезенки	*n*
5 Эмбрионы	75,6	4,85	44,93	7,59	12,65	29.31	0,81	15
6 Сеголетки и годовики	110,0	17,9	33,34	6,93	7,95	25,49	1,61	12
7 Остальные возрастные группы . . .	161,1	54,2	19,0	4,84	5,44	18,23	0,80	50

<u>Key to Table 30</u>:

1) Age 2) Length (in cm) 3) Weight (in kg) 4) Index 4a) Of the lungs 4b) Heart 4c) Kidneys 4d) Liver 4e) Spleen 5) Embryos 6) Underyearlings and yearlings 7) Other age groups

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Affiliation with a particular sex also affects the relative size of the internal organs, which is confirmed by the data in Table 31.

As we can see, the indices in the females are higher than in the males, this difference affecting to a greater degree the lungs, liver and the kidneys. If this picture were observed in the dommon dolphin alone, then this *176 could have been explained by the fact that the females are smaller than the males, and as was demonstrated just a while ago (see Table 30), within the confines of a single species the indices are higher in small specimens than in larger ones. However, this phenomenon is also observed in the bottlenose and in the harbour porpoise, in which, in our material, the females are larger than the males. Thus, the difference in the relative sizes of the internal organs is observed in all of the species regardless of the proportions of the body dimensions of the animals of a different sex. This fact provides a basis for drawing the conclusion that here we are dealing with sexual dimorphism.

Table 31

Indices of internal organs of male and female dolphins.

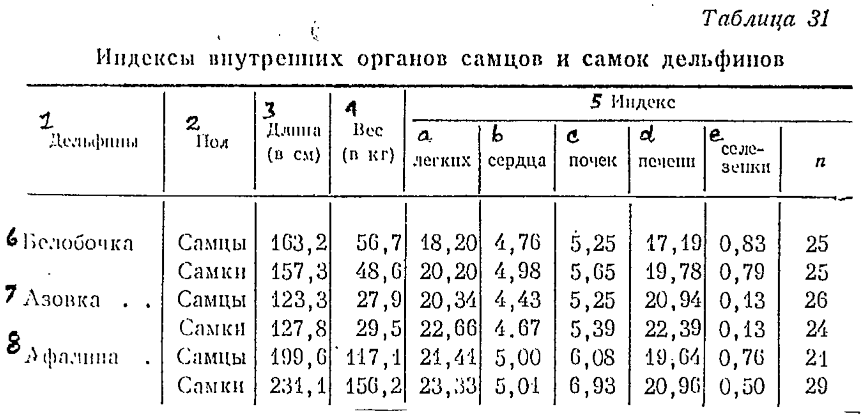

Таблица 31

Индексы внутренних органов самцов и самок дельфинов

1 Дельфины	2 Пол	3 Длина (в см)	4 Вес (в кг)	5 Индекс					
				a легких	b сердца	c почек	d печени	e селезенки	*n*
6 Белобочка	Самцы	163,2	56,7	18,20	4,76	5,25	17,19	0,83	25
	Самки	157,3	48,6	20,20	4,98	5,65	19,78	0,79	25
7 Азовка . .	Самцы	123,3	27,9	20,34	4,43	5,25	20,94	0,13	26
	Самки	127,8	29,5	22,66	4.67	5,39	22,39	0,13	24
8 Афалина .	Самцы	199,6	117,1	21,44	5,00	6,08	19,64	0,76	21
	Самки	231,1	156,2	23,33	5,01	6,93	20,96	0,50	29

Key to Table 31:

1) Dolphins 2) Sex 3) Length (in cm) 4) Weight (in kg) 5) Index

5a) Of the lungs 5b) the heart 5c) the kidneys 5d) the liver 5e) spleen

6) Common dolphin 7) Harbour porpoise 8) Bottlenose

It is interesting that in the embryos and in the underyearlings and yearlings as well, such dimorphism is not observed, a fact evident from Table 32.

Table 32

Indices of the internal organs of male and female common dolphin embryos, underyearlings and yearlings.

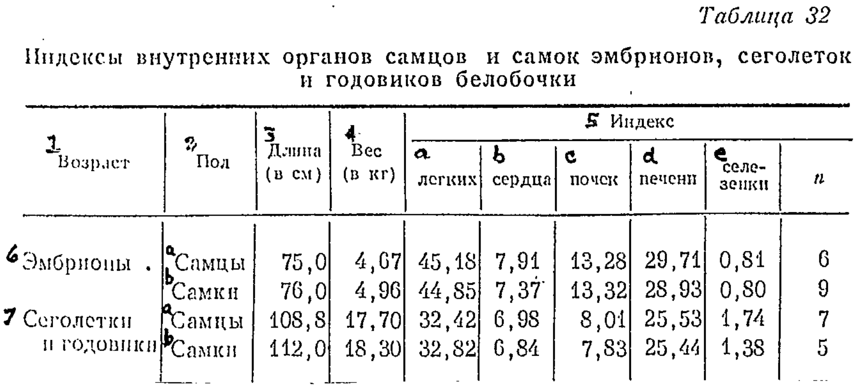

Таблица 32

Индексы внутренних органов самцов и самок эмбрионов, сеголеток и годовиков белобочки

1 Возраст	2 Пол	3 Длина (в см)	4 Вес (в кг)	5 Индекс					
				a легких	b сердца	c почек	d печени	e селезенки	*n*
6 Эмбрионы .	a Самцы	75,0	4,67	45,18	7,91	13,28	29,71	0,81	6
	b Самки	76,0	4,96	44,85	7,37	13,32	28,93	0,80	9
7 Сеголетки и годовики	a Самцы	108,8	17,70	32,42	6,98	8,01	25,53	1,74	7
	b Самки	112,0	18,30	32,82	6,84	7,83	25,44	1,38	5

Key to Table 32:

1) Age 2) Sex 3) Length (in cm) 4) Weight (in kg) 5) Index

5a) Of the lungs 5b) Heart 5c) Kidneys 5d) Liver 5e) Spleen

6) Embryos 7) Underyearlings and yearlings

2a) Males 2b) Females

Hence, one can assume from these data that sexual dimorphism, observed apparently only in the adult animals, develops under the influence of pregnancy. As has been already noted, the young in the dolphin are born relatively large in size. The organism of the female during the final months of pregnancy should therefore be operating with a heavier load, which, apparently affects the development of the organs of respiration to a greater degree, and also the development of the organs of metabolism and excretion. *177

Since the value of the index is determined not only by the weight of the organ but also the total weight of the animal, while fatness, i.e. as a result, the weight of all the animals as well is not the same throughout the year, then it can be said with assurance that in the very same animals the indices of the internal organs throughout the year are not the same.

Let us corroborate this fact with numerical data.

In Table 33, indices for the same species - the common dolphin - are presented for the spring and fall seasons while observing the uniformity of the age-sex composition of the groups being studied. The correspondence of the mean size of the animals, not a result of deliberate selection, confirms an adequate magnitude of our test specimens.

Table 33

Indices of the internal organs of the common dolphin.

Таблица 33

Индекс внутренних органов белобочки

1 Время года	2 Длина (в см)	3 Вес (в кг)	4 Индекс					
			a легких	b сердца	c почек	d печени	e селезенки	(n)
5 Весна	161,4	54,2	19,00	4,84	5,44	18,23	0,80	50
6 Осень	161,0	48,4	21,98	5,73	5,90	21,42	1,08	50

Key to Table 33:

1) Time of year 2) Length (in cm) 3) Weight (in kg) 4) Index
4a) Of the lungs 4b) Heart 4c) Kidneys 4d) Liver 4e) Spleen
5) Spring 6) Autumn

The data of the table confirm that during the period of greatest fatness - in the spring - all of the indices are considerably lower than in the fall - the period of lowest fatness of the animals.

All of this discussion enables one to come to the conviction that within the confines of the same species, the differences in the indices depending on the age and sex of the animals and the biological season are extremely important and that in certain cases they overlap interspecific differences. This must always be kept in mind when comparing the indices in different species or populations of animals.

Uniform material, on the other hand, collected according to a single method and during the same time of year (Table 28) indicates definite constitutional differences among the individual species of dolphin which are determined by the ecological characteristics of these species.

The relative size of the central nervous system of the animals is of considerable interest. *178

By virtue of the above presentation I do not consider it indicative or right to compare our data on the size of the brain in the other cetaceans with data in the literature, therefore I will dwell here only on our own material.

It is necessary to note that the relative weight of the brain as no other organ is extremely highly variable depending on the size of the animal. In larger animals the relative weight of the brain is much smaller than in smaller animals. Let us confirm this fact with figures.

Since the craniums in themselves were valuable material to me for the work in the area of taxonomy, I could not sacrifice a large number of them in order to collect material on the weight of the brain.

Table 34, incidentally, confirms the invalidity of the data regarding the relative weight of the brain in cetaceans presented in the literature where they are reported on the basis of research of one, at best two, specimens. Recognizing that with such large fluctuations in the relative sizes of the brain, our material is also far from adequate, I will nevertheless make bold to approach the determination of the mean indices of the brain in the various species, stipulating that these data cannot be considered conclusive.

Table 34

Absolute and relative weights of the brain in dolphins.

Таблица 34

Абсолютный и относительный вес мозга дельфинов

1 Дельфины	2 Пол	3 Длина животного (в см)	4 Вес животного (в кг)	5 Вес мозга (в г)	6 Индекс мозга
7 Белобочка	a Самец	114	20,4	390	19,12
»	»	122	22,0	470	21,36
»	»	121	22,3	440	19,73
»	»	133	32,0	550	17,19
»	»	191	74,0	645	8,75
»	»	196	78,0	690	8,85
8 Азовка	»	140	34,0	390	11,47
9 Афалина	b Самка	166	70,0	1235	17,60
»	a Самец	188	98,0	1381	14,09
»	»	199	114,0	1618	14,19
»	b Самка	231	165,0	1605	9,37
»	»	236	177,0	2015	11,38

Key to Table 34:

1) Dolphins 2) Sex 3) Length of the animal (in cm) 4) Weight of the animal (in kg) 5) Weight of the brain (in g) 6) Brain index 7) Common dolphin 8) Harbour porpoise 9) Bottlenose a) Male b) Female

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As can be seen from Table 35, the mean brain index in both species is almost identical. In the deep diving bottlenose, the relative size of the brain is even somewhat smaller than in the pelagic common dolphin. *179

Table 35

Mean indices of the brain in dolphins

Таблица 35

Средние индексы мозга дельфинов

Дельфины	n	Миним.	Максим.	Средн.
Белобочка	6	8,75	21,36	12,83
Афалина	5	9,37	17,60	12,58

Key to Table 35:

1) Dolphins 2) Minimum 3) Maximum 4) Mean 5) Common dolphin 6) Bottlenose

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Concerning the size of the brain in the harbour porpoise on the basis of the study of a single specimen, I will not attempt to express any kind of opinion.

The length of the intestine relative to the length of the animal in the dolphins also fluctuates, but to a small degree. Despite the fluctuations, this relationship is expressed in definite figures for every species which is evident from Table 36.

Table 36

Relative length of the intestine in the dolphins.

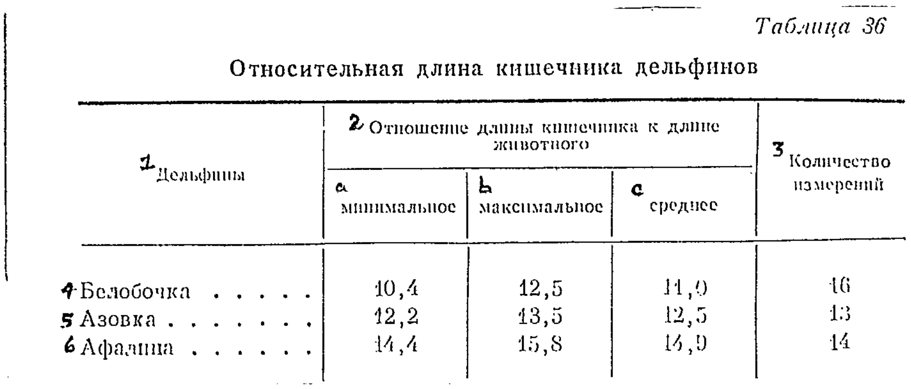

Таблица 36

Относительная длина кишечника дельфинов

1 Дельфины	2 Отношение длины кишечника к длине животного			3 Количество измерений
	a минимальное	b максимальное	c среднее	
4 Белобочка	10,4	12,5	11,0	16
5 Азовка	12,2	13,5	12,5	13
6 Афалина	14,4	15,8	14,9	14

Key to Table 36:

1) Dolphins 2) Ratio of the length of the intestine to the length of the animal 2a) Minimum 2b) Maximum 2c) Mean 3) Number of measurements 4) Common dolphin 5) Harbour porpoise 6) Bottlenose

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One should mention the fact that Flower (1872) had already indicated that the length of the intestine in the bottlenose exceeds the length of the animal by 15 times.

The benthonic bottlenose which dives to great depths and feeds on large fish, has the longest intestine; the pelagic common dolphin, feeding on small fish, has the shortest.

The harbour porpoise in this respect, as with the size of the other organs (see Table 28), occupies an intermediate position.

Turning to the physiological characteristics of respiration in our *180 dolphins, I should like to mention that the gas exchange studies were conducted according to the Douglas-Holden method. The procedure for obtaining air from the animals is set out in the introduction. Unfortunately, we were unsuccessful in collecting material in this respect on the harbour porpoise. Therefore, the comparison will be conducted on two forms, diametrically opposed in their way of life: the common dolphin and the bottlenose.

First of all it should be noted that the rhythm of respiration, especially in the common dolphin, varies highly. Thus, for example, on the 29th of May, 1948 in Yalta, a male 189 cm in length was caught which was breathing very rapidly. He performed 60 respirations in 5 minutes and breathed 95.5 l of air during that time. Since this was the only and very exceptional case, it did not enter into the Tables presented below.

In spite of the fluctuations in the intensity of respiration in the individual animals, the rythym of respiration, and consequently, the type of pulmonary ventilation as well in every species is very definitely specific which is confirmed by Table 37.

Table 37

Ventilation of the lungs in the dolphins.

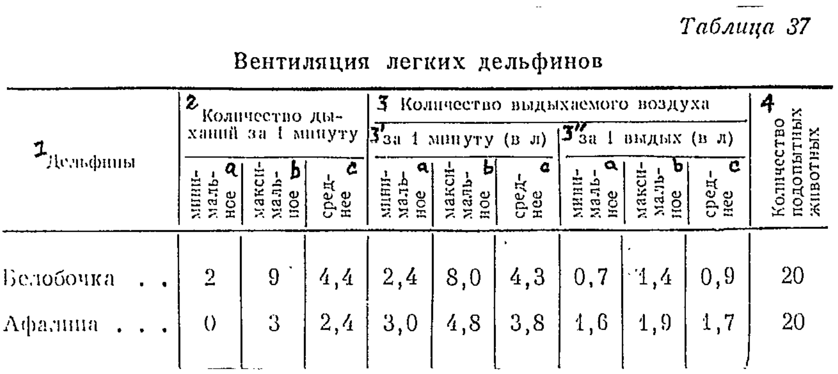

Таблица 37

Вентиляция легких дельфинов

1 Дельфины	2 Количество дыханий за 1 минуту			3 Количество выдыхаемого воздуха						4 Количество подопытных животных
				3' за 1 минуту (в л)			3'' за 1 выдых (в л)			
	минимальное a	максимальное b	среднее c	минимальное a	максимальное b	среднее a	минимальное a	максимальное b	среднее c	
5 Белобочка . .	2	9	4,4	2,4	8,0	4,3	0,7	1,4	0,9	20
6 Афалина . . .	0	3	2,4	3,0	4,8	3,8	1,6	1,9	1,7	20

Key to Table 37:

1) Dolphins 2) No. of respirations per minute 3) Amount of expired air 3') Per minute (in l) 3") Per expiration (in l) 4) Number of subject animals 5) Common dolphin 6) Bottlenose

a) Minimum b) Maximum c) Mean

As we can see, the rythym of respiration in the common dolphin is on the average higher than in the bottlenose - almost two-three times - which ties in nicely with the given respiratory pause for each species (see Table 27). Hence, the ventilation of the lungs as well in the common dolphin is higher than in the bottlenose. But then the amount of air consumed by the bottlenose in one respiration is almost twice as great as in the common dolphin, which fully corresponds to the larger size, and consequently, a larger lung capacity as well in this dolphin in comparison with the common dolphin (see Table 28).

Let us turn to the composition of the expired air in the animals (Table 38)

From Table 38, it is quite clearly evident that the bottlenose consumes considerably more oxygen than the common dolphin and exhales correspondingly more carbon dioxide. This ties in nicely with the biology of the animal. *181 It is quite natural that the bottlenose, diving for a considerable length of time, should utilize oxygen to a greater degree than does the pelagic common dolphin.

Table 38

Oxygen and carbon dioxide content (in %) in the air exhaled by the dolphins.

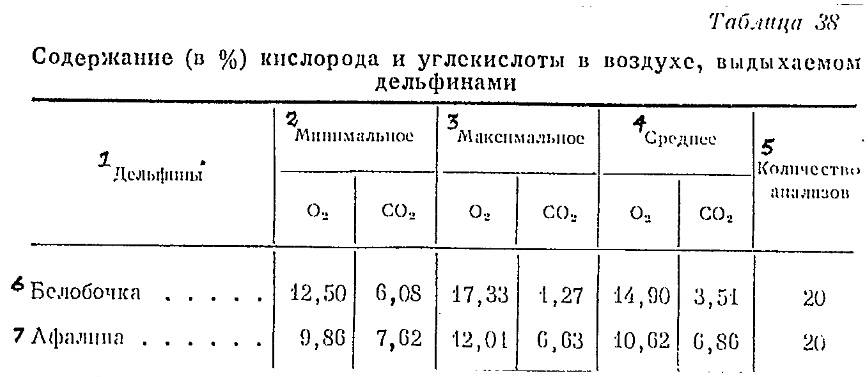

Таблица 38

Содержание (в %) кислорода и углекислоты в воздухе, выдыхаемом дельфинами

1 Дельфины	2 Минимальное		3 Максимальное		4 Среднее		5 Количество анализов
	O_2	CO_2	O_2	CO_2	O_2	CO_2	
6 Белобочка	12,50	6,08	17,33	1,27	14,90	3,51	20
7 Афалина	9,86	7,62	12,01	6,63	10,62	6,86	20

<u>Key to Table 38:</u>

1) Dolphins 2) Minimum 3) Maximum 4) Mean 5) Number of analyses

6) Common dolphin 7) Bottlenose

It should be noted that in both species a direct relationship was observed: the more often the animal breathed, the more oxygen it exhaled and consequently, the smaller amount of oxygen the animal consumed. Thus, for example, that exceptionally rapidly breathing dolphin (a male 189 cm long) which was discussed above, exhaled air which had the following composition: O_2 - 20.40 %, CO_2 - 0.15%. Keeping in mind that 20.96% oxygen is contained in the air in the atmosphere, then that insignificant amount of oxygen that the organism consumed during such unusual rate of breathing becomes clear.

Having at our disposal the data of Tables 37 and 38, the total gas exchange of the animals can be computed with the stipulation that this gas exchange was calculated for animals that were not in the state of motion.

Knowing the amount of oxygen contained in the atmospheric air and the proportions of the pulmonary ventilation of the dolphins, one can, having multiplied these values, calculate the amount of oxygen exhaled by the animal in one minute. Knowing the amount of oxygen contained in the exhaled air, and the proportions of pulmonary ventilation, we obtain by the same means the amount of expired oxygen per minute. By a simple calculation of the obtained values we determine the total oxygen exchange which in the dolphins is expressed by the figures presented in Table 39.

As we can see, the gas exchange in the bottlenose is higher than in the common dolphin, it being interesting that in both the mean as well as in the extreme values the difference is approximately the same.

If the mean figures obtained are compared with the figures on gas exchange in man and the seal presented by Irving (1935a) and others, the following picture will be obtained:

Man........................... - 245- 250 cm^3 O_2 per minute
Seal .... - 370 " " " "
Common dolphin .... - 261 " " " "
Bottlenose dolphin .... - 392 " " " "

As we can see, the gas exchange in the pelagic common dolphin exceeds somewhat that of man. In the forms which shut off their respiration for a longer period of time (in the present case the seal and the bottlenose) the gas exchange is somewhat higher, which is completely natural.

Of great interest are issues such as the effect of helminthiasis and other diseases, age and sex differences on gas exchange, characteristics of gas exchange in pregnant females, etc. In particular, it can be assumed that in pregnant females, especially during the last stages of pregnancy, it should be higher than in the other animals.

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*182

Table 39

Gas exchange in the dolphins (amount of oxygen consumed in 1 min., in cm^3).

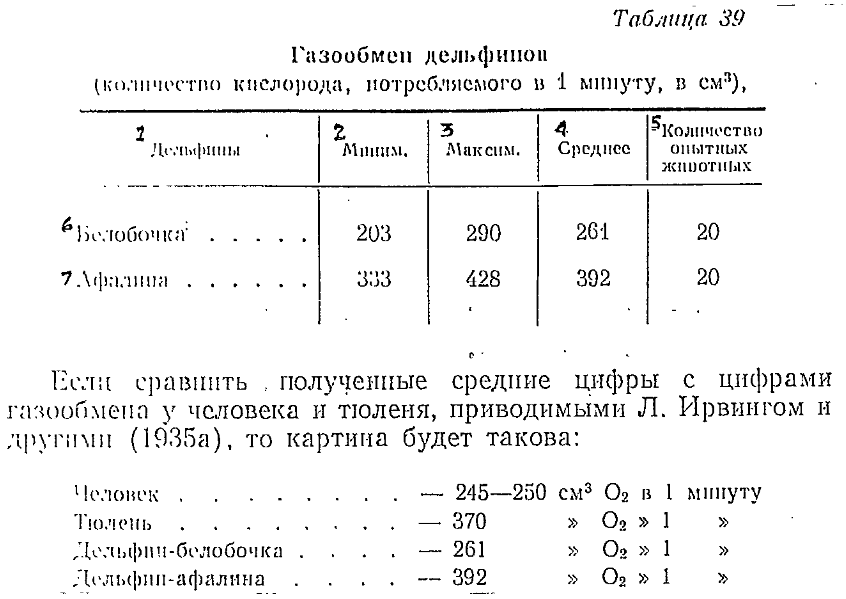

Таблица 39

Газообмен дельфинов
(количество кислорода, потребляемого в 1 минуту, в $см^3$),

1 Дельфины	2 Миним.	3 Максим.	4 Среднее	5 Количество опытных животных
6 Белобочка	203	290	261	20
7 Афалина	333	428	392	20

Если сравнить полученные средние цифры с цифрами газообмена у человека и тюленя, приводимыми Л. Ирвингом и другими (1935a), то картина будет такова:

Человек . . . . — 245—250 $см^3$ O_2 в 1 минуту
Тюлень . . . . — 370 » O_2 » 1 »
Дельфин-белобочка . . . . . — 261 » O_2 » 1 »
Дельфин-афалина . . . . . — 392 » O_2 » 1 »

Key to Table 39:

1) Dolphins 2) Minimum 3) Maximum 4) Mean 5) Number of subject animals
6) Common dolphin 7) Bottlenose

Unfortunately, by virtue of the fact that the procedural methods for the gas exchange studies on cetaceans were for the first time used by ourselves, were unable to collect data for resolving this issue. Therefore, much time was spent on the final acceptance of this method, besides which in the beginning there were unaviodable failures during which period time went by uselessly. It is understandable that I tried primarily to guarantee the obtainment of data on the specific differences in gas exchange which are in fact presented here.

Thus before us are three species of dolphin, inhabiting the same water body and feeding on fish. In addition to that, the ecology of these species is different. Their dispersion, nature of distribution and behavior in the water body are all different. And closely corresponding to these differences, the morphological and physiological indicators of these animals differ. In short, every species has its own characteristics which are closely *183 interrelated with the characteristic of its habitat.

3. REASONS FOR THE MARKED PREDOMINANCE IN THE ABUNDANCE OF THE COMMON DOLPHIN IN THE BLACK SEA

The abundance in the populations of the individual species of dolphin in the basin under consideration differs sharply. According to our data, in the pre-war years - the years of the greatest development of the industry - the ratio of the dolphins caught in the Black and the Sea of Azov (only on our water area) was expressed by the following figures (Table 40).

Tsalkin presents (1940a) similar figures.

These data, based on statistics of exploitation of the various species of dolphin, although they of course give only a relative idea of the ratio of the sizes of the populations of the various species, they at the same time clearly show that the common dolphin has an enormous superiority, i.e. the pelagic form, widely distributed and inhabiting practically all of the water area of the Black Sea. Second place, many times inferior in abundance to the first species, is occupied by the Azov dolphin, i.e. basically benthonic form distributed primarily throughout the Sea of Azov and the Kerch Strait and partly the Black Sea as well, inhabiting only the littoral waters and confining itself to shallow waters localities. And finally, last place according to abundance is occupied by the bottlenose, a benthonic form distributed throughout the Black Sea, also inhabiting only the littoral waters but is not connected with the shoal waters in its distribution.

Table 40

Role of the various species in the total catch (in % of the catch of common dolphin.

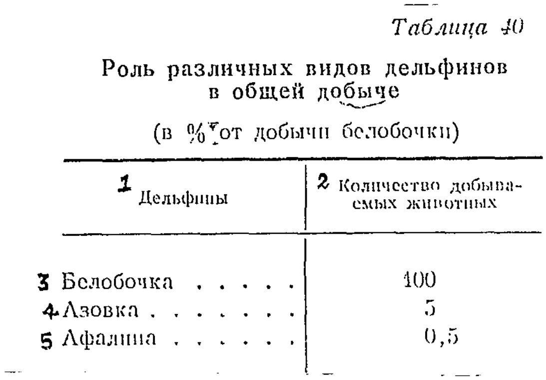

Таблица 40

Роль различных видов дельфинов в общей добыче

(в % от добычи белобочки)

1 Дельфины	2 Количество добываемых животных
3 Белобочка	100
4 Азовка	5
5 Афалина	0,5

Key to Table 40:

1) Dolphins 2) The number of caught animals 3) Common dolphin

4) Harbour porpoise 5) Bottle-nose dolphin

The comparative scarcity of the benthonic forms is related to the extreme limitedness of their food base. As is well-known, the benthos in the Black Sea is distributed only in a narrow band along the coasts. This relationship between the scarcity of the benthonic forms and the limitedness of their food base was already noted not only by me (1938) but also by V. A. *184

Vodyanitskii (according to Mal'm 1938) and Tsalkin (1940a).

Turning to the incomparably numerous form - the common dolphin - it should first of all be emphasized that such a concentration of this dolphin as in the Black Sea, judging by the literature, is not found in any other body of water.

It is quite evident of course that such a superiority of this pelagic form is related to the incomparably greater wealth of the Black Sea in pelagic fauna. But how can the fact that it was precisely the population of the common dolphin that flourished so vigorously in the Black Sea be explained? And how can this fact be tied in with the view, prevalent even up until the present, on the low natural productivity of the Black Sea?

It would appear that the answer to this question lies in the very nature of the Black Sea which produces an ideal habitat particularly for the common dolphin, and the opinion regarding the low productivity of the Black Sea is obviously incorrect.

In analyzing the feeding of this dolphin, it has already been noted that it bears a purely pelagic character. According to S. M. Malyatskii's (1938) observations, bottom fish occuring in the ration of the common dolphin are eaten only when these fish lead a pelagic way of life. Finally, Police (1932) indicates that in the Mediterranean Sea as well, this dolphin also feeds only on representatives of pelagic fauna and only in the surface waters.

As was already demonstrated, the constitution and physiology of this dolphin confirm the fact that it is incapable of prolonged diving. Thus, before us is a form adapted to life only in the surface layers of the water and sustaining its existence only in these layers.

Of great interest in connection with this is a conclusion by Vodyanitskii (1930) who, while examining the origin of the ichthyofauna of the Black Sea, came to the conclusion that "in the Black Sea, only such Mediterranean species of fish which retained their abode in the surface layers of the water or near the shores throughout all of the stages of their development became naturalized" (p. 27). This condition can be fully applied, as we can see, to the delphine fauna as well without any changes whatsoever..

In another work, noting the strong predominance of pelagic forms in the Black Sea, and in particular, pelagic fish, Vodyanitskii (1937) wrote the following: "The overwhelming significance of the anchovy in the Black Sea both in relation to the total bioeconomy of the water body as well as in commercial significance, characterizes the singularity of the Black Sea-Azov basin, since in no other sea does the anchovy play a similar role" (p. 1525). One can only add to this fact that the common dolphin itself as *185 well does not play a similar role in any other sea "both in relation to the bioeconomy of the water body, as well as in commercial significance.

Thus, general features, specific only to the Black Sea are observed in both the ichthyofauna as well as in the mammalian fauna of this sea.

The specificity of the Black Sea consists to begin with, in the presence of hydrogen sulphide domes occupying the abyssal zone beginning from the bottom, and in certain places, approaching near the surface of the sea. Hydrogen sulphide precludes, of course, the possibility of life (besides bacteria) in the abyssal regions of the Black Sea and on the bottom (with the exception of a narrow coastal strip).

The absence of live planktonic, nektonic and benthonic organisms at depths below 183 m was established for the first time by N. I. Andrusov (1890) and subsequently corroborated by Ostroumov (1892a).

Zernov (1904, 1913a), whose works laid the basis of ecological studies of the plankton in the Black Sea, confirmed the absence of plankton in the abyssal sections of the sea and demonstrated a gradual reduction of its quantity from the surface layers into the depths. Knipowitsch's (1932) studies gave the same results.

The unique character of the vertical distribution of the plankton in the Black Sea, consisting in a sharp decrease in its quantities from the surface layers into the depths, was demonstrated by Nikitin (1926, 1929, 1939, 1945), having confirmed in this way Zernov's (1904, 1913a) data.

Presenting a chart of the vertical distribution of the plankton biomass in the Black Sea, Nikitin (1945) notes that the lower boundary of the plankton passes through the central parts of the sea and near its western coastlines at depths of 100-125 m. In the littoral zone of the other sections of the sea, it passes through at depths of 150-175m, the plankton being completely absent at depths of 125-150 m over large expanses of the sea area. "The vertical distribution of the average plankton biomass," writes Nikitin (1945), "in 25 m layers is presented in the following form (in mg/m^3): 0-25 m 210mg, 25-50 m 147 mg, 50-75 m 121 mg, 75-100 m 84 mg, 100-125 m 90 mg, 125-150 m, 54 mg, 150-175 m 38 mg ..." (p. 529).

A similar picture of the vertical distribution of the plankton biomass is presented in a recently published study by A. P. Kusmorskaya (1950).

Summarizing the published data on the zooplankton which is the food base of pelagic fish and the data on pelagic fish by Vodyanitskii (1930, *186 1936, 1937, 1939, 1941, 1951), S. M. Malyatskii (1938, 1939, 1940, 1940a) and others, it can be concluded that in the Black Sea all life is concentrated only in the surface layers of the water and the nearer to the surface, the richer it is. It's as though the hydrogen sulphide cupola supports the organisms near the surface of the sea where all life in the water body is concentrated.

It is precisely in this that the uniqueness of the Black Sea is contained, and it is precisely this, in my opinion, that explains such a vigorous development in it of the pelagic fish and the pelagic common dolphin whose morphology and physiology corresponds so to the specificity of the Black Sea.

While not examining the entire issue of the productivity of the Black Sea, I want to express only some facts in this respect.

It appears that one can only subscribe to Vodyanitskii's (1937) conclusion regarding the fact that "it is impossible to compare the productivity of a shallow water body of a limnetic type, in addition to which it is profusely supplied with fluvial tributaries, with the production of an actual deep sea..." (pp. 1523 - 1524).

It is also impossible not to agree with Vodyanitskii (1941) in the fact that taking into consideration the specificity of the Black Sea, all calculations on its productivity should be conducted not on the entire depth of the water but only on the productive thickness of the surface layers. Using such a method of calculation, the Black Sea, according to the amount of nitrates and phosphates, has even a greater productivity than many other seas, especially the Mediterranean Sea.

Kusmorskaya (1950), in comparing the development of the plankton of the Black Sea with that of the Caspian, by no means considered to be unproductive, emphasizes that "the open portion of the Black Sea is close to the Central and Southern Caspian according to the development of food plankton" (p. 212).

Let us see how matters stand with fish productivity of the Black Sea, taking into consideration only the pelagic fishes and conducting the computation in accordance with the specificity of the sea - on a unit area of the water body and not on its volume.

According to Vodyanitskii (1937, 1951), the commercial fishing industries of all the states of the Black Sea recover 2.5 kg of fish per 1 ha of area or 2.5 g from 1 m^2 of area, and according to H. Harvey (1950), in the North Sea which is not considered to be unproductive, there is in all only 1.5 gm of pelagic fish for every 1 m^2 of sea area. In connection with this it should be noted that the figure of 2.5 g from 1 m^2, being an indicator of the present-day commercial productivity, of course does not reflect by far the true situation in the nature inasmuch as the open waters of the Black Sea have not as yet been exploited by the industry thus far. Finally, the number of pelagic common dolphin feeding almost exclusively on pelagic fish, can serve as a certain indicator of the total biomass of fish *187
per unit area of the Black Sea. Vodyanitskii (1937, 1951) used this indicator for calculations in his latest works.[1] Establishing the numbers of dolphins in the Black Sea at approximately 500,000 head, and proceeding from the fact that every animal eats no less than 5 kg of fish per day, he considers that the dolphins alone consumes no less than 2,500,000 kg of fish annually for its sustenance. Considering the area of the Black Sea to be equal to 40 million ha, Vodyanitskii (1951) calculates that the dolphins obtain more than 20 kg of fish from 1 ha of sea area while the commercial fishing industry recovers only 2.5 kg from 1 ha per year.

In so far as the base values, and namely the number of dolphins in

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[1] The Rumanian economist O. A. Anastasiu (1940) basis his conclusions on this indicator as well.

the Black Sea and the amount of food consumed by a single dolphin in a day are still unknown, the presented calculations can be considered only hypothetical. It seems to me, for example, that the final figure of Vodyanitskii's can be increased four times and perhaps even more, and in general, values which are not as yet accurately established should not be invested in the figures.

In spite of this observation, one can only associate oneself with Vodyanitskii (1951) when he writes: "we have not as yet by far exploited the world of open waters of the Black Sea" (p. 14) and "the wealth of pelagic fish in the open portions of the Black Sea is no longer subject to doubt at the present time" (p. 15).

Vodyanitskii's views (1930, 1936, 1937, 1939, 1941) on the productivity of the pelagic zone of the Black Sea were developed in the works of Malyatskii (1938, 1939, 1940, 1940a).

In connection with this, one automatically recalls a remarkable thought of N. Borodin's expressed by him yet in 1902. Borodin (1902) had already written at that time: "It is precisely in freeing the fisherman from the shores in the sense of the possibilities of fishing far removed from it, that a strong guarantee of further development of deep sea fishing in the Black Sea lies" (p. 917).

Unfortunately, this concept of Borodin's, confirmed by contemporary researchers, is still not realized at the present time. And it seems to me that it is precisely in this that the existing disagreements regarding the productivity of the Black Sea lie.

In summing up, it can be concluded that a comparison of the data in the literature regarding the productivity of the Black Sea and the data on the feeding of dolphin in it, leads to a conclusion that the fluorishing of the common dolphin in this sea is explained by its remarkable adaptability to the uniqueness of the Black Sea.

CHAPTER IV

AN APPRAISAL OF THE STATE OF DOLPHIN STOCKS IN THE BLACK SEA AND THE SEA OF AZOV

OBSERVATIONS ON THE THEORY OF POPULATION DYNAMICS OF ANIMALS

Animal numbers, one of the central problems of contemporary ecology, is of great economic significance. *188

This problem has particularly important consequences in our country, i.e. in conditions of a planned socialistic economy.

Under the influence of a rapacious industry, the Steller's sea cow living in our waters has disappeared entirely. Likewise, the bowhead whale is almost completely exterminated. The stocks of walrus in the European North are extremely severely depleted.

The old world beaver [Castor fiber - Trans.] profusely populating at one time the entire Eurasian continent, was completely exterminated almost everywhere in Europe, the first country where the beaver was destroyed already towards the beginning of the XIII century being England. In Russia at the time of the Great October Socialist Revolution, the beaver was on the verge of complete extinction and if it were not for drastic measures, about which I have already written (1945a), adopted for its preservation by the Soviet government, we would have lost this valuable animal from our fauna. Many such examples can be quoted.

In our country in a consciously guided socialistic culture, a planned utilization of natural resources is being developed with a prudent attitude toward them. This is precisely why the problem of animal numbers in our country takes on such great significance.

The fluctuations in animal numbers has long attracted the attention of scientists. The first study in this respect, belonging to N. V. Turkin (1900) appeared in Russia. Much later, similar works appeared abroad. Thus, references to G. Hewitt's work (1921) as the primary source in this trend *189 are simply incorrect.

Not concerning myself at all here with the numerous studies on the fluctuations in numbers of the small rodents and fur-bearing animals, I will only note that the issues on the population dynamics of acquatic animals at the present time have been developed basically on the basis of fish.

Not touching on the issue of the biomass of fish per unit area in a body of water, the bases for the proper solution of which were laid down about a hundred years ago by the Russian academician K. Baer (1854), I will attempt to clarify the contemporary situation of the problems of population dynamics in ichthyology in a most abridged and schematic form.

Two completely different trends are outlined here.

One of them is based on mathematical laws resulting from the intensity of the fishing industry. Various statistical methods are closely affiliated as well. In our country, this trend was developed by F. I. Baranov (1918, 1925 et al.) and abroad by W. Ricker (1946, 1948), G. Clarke (1946), G. Kasteven (1950) and others.

Since the population dynamics of any animal is a biological phenomenon, then it is determined first of all by the biological, and not mathematical laws. It is understandable therefore, that this trend received a negative rating at the last Conference on the Problems of the Fishing Industry convened by the USSR Academy of Sciences and the USSR Ministry of Fisheries in December of 1951 (see the resolutions of this conference).

The other trend has as its basis another, essentially a biological, approach to this issue. This trend was being developed lately in our country mainly in the works of G. H. Monastryskii (1940, 1949, 1952 et al.), V. V. Vasnetsov (1947), Nikol'skii (1950, 1950a) and other Soviet ichthyologists. This approach, based on the proper understanding of the harmony of the organisms and the environment, has as its basic premise S. A. Severtsov's (1941) theory of population dynamics of animals, apropos of which academician E. N. Pavlovskii (1952) wrote the following: "In the area of interpretation of the population dynamics of fish, the majority of ichthyologists correctly proceed from the position advanced by Severtsov that the nature of population dynamics is a species adaptational property..." (p. 492).

In contrast to foreign ecologists, S. A. Severtsov saw in the fluctuations of animal numbers not an activity of the external environment in itself such as the activity of sun spots, and not as a manifestation of an equilibrium between the organism and the environment, but as a manifestation of harmony of the organism and the environment, the unity and form of which is developed during historical development.

This view was particularly clearly manifested in S. A. Severtsov's last works (1951a, 1951b). *190

N. A. Severtsov (1855), on the basis of personal observations of birds in nature, had already come to the conclusion regarding the existence of a correlation between fecundity and life span of the animals, i.e. the shorter the life span of the animal, the greater its fecundity, and conversely, the longer the life span, the lower the fecundity. He wrote: "Here we see a polarity between feeding, the sustenance of the organism on the one hand, and molting and procreation on the other, and depending on the dominance of one function or the other, the race (species - S. K.) is sustained either by rapid reproduction or by the longevity of the individuals, but never by both at the same time". Adding a footnote, Severtsov writes: "This law is common to all animals, breathing dry air, by means of an internal respiratory apparatus, lungs or trachea" (1950 edition, p. 216)

This position was developed on the basis of mammals by S. A. Severtsov (1930). It should be noted that one of N.A. Severtsov's works (1945, v. 3, pp. 283-288) was devoted to the problem of animal numbers in which he posed a question regarding the relationship between the abundance of a species and the mortality rate at different stages of individual development.

Thus, we can see that this problem had an effect on the works of the representatives of three generations of Severtsovs, the most complete treatment of the problem belonging to a representative of the third generation, namely S. A. Severtsov.

The theory of population dynamics of animals is set out in full in a book by S. A. Severtsov (1941) and in several of his subsequent articles (1942, 1951b).

According to S. A. Severtsov, the dynamics of the populations of animals is determined by three basis elements: natural life span of the individuals of a species, fecundity (covering the time up until the onset of the first child bearing, frequency of child bearing and the number of young in a litter or brood) and mortality, Severtsov demonstrating that within the same species the mortality coefficient is different depending on the age, and in ploygamous species - on the sex of the animal as well.

It goes without saying that a clarification of all of these elements is possible only on the basis of the knowledge of the details of the ecology of a species.

Having established the species constants of reproduction in animals,

and having clarified the indices of specific fecundity, life span and mortality, S. A. Severtsov (1941) reconstructs the population dynamics of 19 species of mammals and birds. The author's basic conclusion is in the fact *191
that for every species there is a distinct population dynamic, specific only to that species; it is entirely founded and extremely convincing. "The population dynamics of the individual species, "writes S. A. Severtsov (1942), "has specific characteristics for every species; in addition to that, types of dynamics can be established which are common to related species" (p. 38).

The author calls population dynamics a quantitative expression of the intensity of the struggle for existence, or a numerical expression of the adaptability of a species. It would appear that one should go farther in this interpretation. It is obvious that population dynamics is not the result of the adaptability of a species, but one of the forms of adaptation developing together with other forms in the process of the evolution of animals. The works of S. A. Severtsov (1951b), especially one of the recent ones, leads up close to this conclusion.

As a result, the gist of S. A. Severtsov's theory consists in the fact that he demonstrated species specificity of a type of population dynamics of animals on the basis of concrete data demonstrated that this type is one of the forms of adaptability of a species developing during the process of evolution. Therefore, G. V. Nikol'skii (1950) is entirely correct when he writes: "S. A. Severtsov was, as far as I know, the first zoologist who pointed out that 'the type of dynamics of population (species - G. N.) is no less characteristic of the population than its morphological attributes and its interrelationship with the environment is determined by it'.

Later, Monastryskii continued this point of view as it applies to fish and formulated his own concept regarding types of spawning populations, i.e. he postulated a species specific mortality curve of the populations" (p. 18).

Thus Monastryskii (1940, 1949, 1952 et al.), in resolving this problem in ichthyology, developed a biological trend which considers the fluctuation in numbers not as a result of a unilateral effect of the commercial fishing industry on a population, but as a result of the interaction of the adaptation of a species and factors of the external environment.

Great attention is justifiably given to qualitative biological indices. As Vasnetsov (1947) demonstrated, growth of fish is also an adaptive property of a species. Growth is very variable up to the onset of sexual maturity. The more favorable the environmental conditions, the more rapidly the fish grows and the earlier the onset of its sexual maturity. It is quite evident that an earlier onset of sexual maturity guarantees a greater recruitment[1], and consequently, an increase in the abundance of the population.

Returning to our dolphins, it should be mentioned here that these three ecologically different forms differ sharply according to their population numbers in the basin as well. In the preceding chapter, the relationship between the abundance of the species in the basin and the size of the food base was noted. However, it goes without saying that it is impossible to consider the food base as a mechanism which directly determines the abundance of a species. It is without question that the abundance of a species is determined by a certain dynamics adapted to specific conditions of an environment, including the size of the food base as well. Thus, we *192

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[1] Trans. note: Ricker (p. 192) defines <u>popolnenie</u> as "recruitment, fish joining an exploited stock for the first time".

can conclude that the types of population dynamics of our dolphins are apparently different. It would appear that these differences are caused first of all by the natural mortality coefficient.

It is evident, for example, that for the bottlenose, represented in the basin by the smallest number of individuals, mortality factors affect the population more intensely than they do the other species. It is possible, of course, that even the intensity of reproduction in the bottlenose (which, unfortunately, is unknown to us) is something other than in the other species. Taking the harbour porpoise and the common dolphins as examples, we can speak with a great amount of certainty regarding the fact that precisely the differences in the rate of natural mortality and in the life span of the animals determine the tempos of population dynamics, for there are no particular differences in the rate of reproduction of these species (see Chapter II).

As was mentioned above, the type of population dynamics of any animal can be explained on the basis of the determination of three basic values: the life span of the animal, the rate of reproduction and the natural mortality coefficient. At the present time we do not know these values.

Thus, the life span is known to us only for the common dolphin (which will be evident from later discussion); we have no data for the other species in this respect.

We know the intensity of reproduction for only the common dolphin as well. For the harbour porpoise, this component is known already to a lesser degree, and it is completely unknown for the bottlenose. The effect of growth on the intensity of reproduction, on the other hand, is unknown to us for all of the species.

The natural mortality coefficient is completely unknown for any one of the three species we have named. For the time being, we can only speak of mortality factors (and even then without certainty that we have considered them all). In addition to that, it is quite clear that not knowing the natural mortality coefficient, we cannot speak of population dynamics. In connection with this, Monastyrskii (1940) correctly pointed out: "We cannot accurately ascertain the size of the roach stocks in the Southern Caspian since we have practically no quantitative data on the mortality rate of the fish at our disposal. At the present time, we can only discuss the issue regarding the magnitude of the roach stocks" (p. 161). *193

Summing up what we have said, we have to acknowledge that the population dynamics of the Black Sea and the Sea of Azov dolphins remain unknown to us. It is with great regret that given the present level of knowledge, we are unable to approach at the present time the determination of the stocks of animals in the basin from the point of view of the theory of population dynamics.

Meanwhile, the determination of the stocks, even the development of methods for estimating the stocks of any commercial animal is extremely important. This factor makes it necessary to search for other empirical means for resolving the raised issue. We will in fact turn to the examination of these means.

2. METHODS OF DIRECT CALCULATION OF THE STOCKS OF MARINE ANIMALS

The introduction into the commercial industries involving marine mammals of advanced gear, high-speed motorized vessels and aircraft, directing the commercial vessels to located concentrations of animals, together with the progress of the commercial industry and its increasing intensification, gives rise to grave apprehensions for the state of the stocks of the objects of the industry. Emerging is an immediate danger of a rapid and complete depletion of the stocks of species valuable in economic terms and is becoming more real because of the slow rates of reproduction in all of the marine mammals.

In this respect, the history of the whaling industry in the North is extremely instructive, where in a relatively short time the bowhead whales were exterminated.

In connection with this, N. A. Smirnov (1928), a most prominent expert on pinnipeds and cetaceans who laid the basis of a systematic study of these animals, wrote: "In the eighties of the last century, two small Russian enterprises worked on the Murman Coast but they had no success: the industry was based on the utilization of a stock in common with the Norwegians, but it had already been quickly depleted by the latter and the enterprises had to be shut down. G. Hebel, the manager of one of them, explained to me the failure by the fact that the whales went away some where for the lack of plankton, but we had already seen that they could not return even by restoring the food reserves because these very same whales went into the extraction kettles from where there is no return. At the present time, the whales are caught singly and in schools so rarely that there is no basis for thinking of an industry. In the arctic section of the Barents Sea, the right whales had already been killed off more than a century ago, in testimony of which are the remains of Dutch blubber melting furnaces on Novaya *194 Zemlya..." "...Thus, we have seen how the whaling industry developed, declined, migrated and developed again; we have seen the primitive industry of the first stage, though it took a hundred years, but it nevertheless exterminated the Atlantic right whale; how the industry of the second phase achieved the same results, in some places in a hundred years, in others in decades, and how the present-day industry does the same thing in a short number of years. We have also seen attempts at regulating the industry, even though gropingly, without preliminary accurate research, but nevertheless intelligent ones, because to wait for the end of research in this matter is sometimes equivalent to the loss of the subject of research" (pp. 985-986).

It was precisely this factor, i.e. the possibility of losing the subject that prompted the search for empirical means of ascertaining the stocks of animals. It should be noted, however, that in the search for these means for the pinnipeds and cetaceans, there is an essential difference conditioned by the biology of the animals. As is well-known, the pinnipeds cannot do without a firm substratum (ice, land) where in certain periods of their lives (reproducing, shedding), these animals form large and dense rookeries for long periods of time. Thus, a direct determination of pinniped stocks on any limited expanse, i.e. an estimate of their numbers becomes essentially possible.

Testimony of such a possibility is the well-known study of S. V. Dorofeev and Freiman (1928) when the stock of a White Sea herd of harp seal was estimated by means of an aerial photographic survey. This method is based on the above indicated biological characteristic of pinnipeds.

Chapskii (1951), expressing valid critical comments in connection with the computations on the estimates of the White Sea herd of harp seal conducted earlier, proposes his own method. Having at his disposal more accurate data in the area of biology of reproduction, the author takes as his base value the number of offspring taken by the industry, writing: "Clear evidence available to the author of the adequacy of utilizing rookeries created a firm conviction that the size of the remaining rookery in no way exceeded the harvested portion of the offspring" (p. 253). Taking into consideration the negligible percentage of barren females in the herd and the magnitude of the natural mortality rate of the offspring in the first month of life, Chapskii considers that the numbers of offspring are close to the size of the stock of mothers in the herd. Proceeding from these premises, he turns to the computation of the stocks of the animals, which, according to his calculations turned out to be considerably smaller than than those indicated by Dorofeev and Freiman (1928). In conclusion, Chapskii (1951) comes to the conclusion that "more accuracy in the size of the total stocks of the herd should follow in the process of further study using aerial photographic surveys of the 'juvenile' animals" (p. 254). *195

The ratio of the various age groups of the animals in the harvest of pinnipeds was also used as an indicator of the state of the stocks. The works of Dorofeev (1939) and Chapskii (1939) and others, are of such a nature. The beginnings of the study of harvest quotas of pinnipeds were laid in our country by N. A. Smirnov (1928).

Thus, we see that even in the pinnipeds, the direct calculation of the stocks of which is facilitated by biological characteristics, such a calculation method is in a stage of elaboration and refinement. One can speak more accurately on the condition of the stocks rather than on their calculation. The latter situation is even more applicable to the Cetacea who spend all of their lives in the water, than to the pinnipeds. The development of a method for determining the population numbers of these animals on the basis of empirical data, it seems to me, is presently impracticable. On the other hand, the development of a method for estimating the state of the stocks and the effect of the industry on the population which in practice is of no lesser major significance, is quite practicable. Before turning to its exposition, I must dwell on the attempts at direct calculations of the stocks of cetaceans.

Working intensively on the development of a method of calculating the stocks of the Black Sea dolphin from an airplane is A. P. Golenchenko, whose interesting data are unfortunately not yet published. On the other hand, a method for calculating the beluga stocks in the Kara Sea, which is of direct interest to us, has been published by S. K. Klumov (1939). We shall have occasion to dwell on it.

Klumov's basic premise is the fact that the entire Kara Sea beluga population leaves for the Barents Sea for the winter, the beluga "proceeding either by skirting Novaya Zemlya from the north," writes the author, "or by following the straits, sometimes using both routes. It is here in these very places, during its autumn migration, that a simultaneous calculation of the Kara beluga school should be conducted". (S. K. Klumov, p. 39). This fact in itself elicits no comments. However, the author's subsequent calculations are not only unconvincing, they even evoke a feeling of astonishment.

Thus presenting an experiment on calculating the numbers of a school of beluga proceeding along the coast of Sakhalin Island, Klumov (1939) writes: "On July 31, 1930, an approaching school of beluga was spotted from the observation tower of the factory "Lyuga'. The animals were proceeding along the shore in an even 'strip' whose width was approximately 200-300 m. The number of animals in this school was estimated by us in the following manner: the spotter, standing on the shore, had a small stick before him. Holding the latter at a distance from his eye, he counted the animals appearing on the right side of the stick (the movement of the beluga was from left to right). As a result of the count, a figure of approximately 4 thousand head was obtained" (p. 19).

Further, the author adopts a coefficient which he established in collaboration with Dorofeev (1935), in accordance with which, simultaneously, only one third of the school is visible on the surface of the water. It is true that Klumov himself states that during swells on the sea and during reduced visibility, this coefficient could equal one sixth. However, adopting the first figure, i.e. one third, he writes: "In this manner, the estimated school of beluga consisted of approximately 10-12 thousand individuals" (S. K. Klumov, 1939, 9. 19). The time it took for the beluga to pass through was estimated at 4 hours.

After this follows a remarkable interpolation. Taking as a basis a letter of an eyewitness which reads as follows: "On the 10th of November I observed a mass passage of beluga from the Kara Sea through the Strait of Yugorskii Shar westward. The beluga went by throughout the entire day without interruption, at times covering the entire visible expanse of the Strait," the author writes: "Proceeding from the experiment on the calculation of the beluga on Sakhalin Island, we can assume that no less than 35 thousand head of beluga passed through the Strait of Yugorskii Shar on November 10, 1932 throughout the entire day (i.e. 12 hours)" (ibid., p. 19-20). Quoting accounts of eyewitnesses who were at the time near the Strait of Karskie Vorota and on Cape Zhelaniya, and who related that they saw "schools of thousands of beluga", Klumov (1939) concludes: "A correlation of all the observations gives us the right to propose a hypothesis that the numbers of the Kara population of beluga amounts to at least 40-50 thousand head" (p. 20).

Considering that the ratio of the sex groups is 1:1, and that only one third of the females give birth annually, the author writes: "Thus, the annual off spring of the Kara beluga, taking its numbers as 40-50 thousand head, will be expressed in one case as: $\frac{40,000}{2} : 3$, which when rounded off consists of 6500 head. Discarding 40 % of the entire number of offspring to natural mortality and retaining 20 % for growth of the school, we arrive at an acceptable catch quota figure of 2.5-3 thousand head. In the other case, taking the numbers of the Kara beluga population as 50 thousand head, by the same calculations we arrive at 3-3.5 thousand head (in round numbers)" (ibid., p. 20).

In connection with similar calculations, a number of doubts and questions automatically arise.

1) It is extremely doubtful that it would be possible to count up *197
animals in figures of the order of 4 thousand with the aid of a little stick.

2) How is it possible to maintain that if a school of beluga numbering 10-12 thousand individuals passed by the coast of Sakhalin Island in 4 hours in July of 1930, then three times the number of animals passed through the Strait of Yugorskii Shar in 12 hours in November of 1932? Is it possible that the beluga throughout its entire range moves in schools of equal density and with equal speed? Not to mention the fact that at the latitude of Yugorskii Shar in November, the length of the day when the spotter could see "the entire breadth of the Strait" cannot be 12 hours.

3) Is it possible that the entire Kara school of beluga passes through into the Barents Sea during the course of one day and never travels by night?

4) On what basis is this figure of 40 % natural mortality based, which the author so lightly "discards" in his calculations?

5) Is it possible to base calculations on a coefficient that fluctuates within the range of 1/3 to 1/6, etc.?

One can pose many questions of a similar nature. Nevertheless, there is another fact that is even more astonishing. Presenting a figure on the stocks of the Kara beluga which he computed, Klumov adds a footnote here in which he writes: "We do not of course consider that this figure is to any degree scientifically founded, nevertheless, by way of a first approximation, we considered it possible to publish it" (ibid. p. 20). The question is how is it possible, using as a base a figure which the author himself admits is not "scientifically founded to any degree" make calculations on catch quotas and direct a commercial industry on the basis of these quotas?

V. A. Arsen'ev (1939) writes the following in connection with the calculations presented above: "But S. K. Klumov's attempts should nevertheless be welcomed because this is the first experiment in calculating the numbers of an entire population of cetaceans" (p. 97). I will venture to disagree with this conclusion because I consider that figures should never be vested with personal conjecture and to direct a commercial industry on such figures is simply unacceptable.

Yet another attempt at estimating the population numbers of cetaceans belongs to Mal'm (1936a). The author "using methods based on the theory of probabilities involving figures on catches of age groups and also biological cata concerning reproduction of the dolphin" (p. 84), attempted to approach by means of mathematical calculations the calculation of the size of the Black Sea common dolphin stock. Not going into detail in the discussion of this witty, interesting work, and not in the least trying to *198 detract from it, I will only note that if the size of the Black Sea dolphin stock was in fact determined by the figure that the author worked out, then with the proportions of the industry as it existed at the time, the entire stock of the Black Sea dolphin would have been caught out completely in approximately 3-4 ensuing years. As a matter of fact, how do we know that this did not happen. Thus, Mal'm's method (1936a) must be acknowledged as practically unsuitable.

This is how matters stand with the methods of direct calculations of cetacean stocks. This situation strengthens my conviction that without applying technology at our level of knowledge, the calculation population number of cetacean can hardly be said to be practicable. Considerably more workable is the development of methods of estimating the state of the stocks, which in practice, and I repeat, is of no lesser major significance.

3. METHODS OF ESTIMATING THE STATE OF THE BLACK SEA DOLPHIN STOCKS

I attempted to approach the development of a method for estimating the state of the Black Sea dolphin stocks by analyzing the age-sex composition of the catches over a period of years (S. E. Kleinenberg, 1939). At the time, data for the years 1933, 1934 and 1935 numbering 38, 273 animals were analyzed. The following factors served as basic premises.

1. An annual seine net catch of dolphin is a sufficiently large test sample, an entire school or a greater part of it usually being encircled by the seine net, meaning that the feature of selectivity in conditions of a catch is almost excluded. As a result, it can be assumed that the age-sex composition of the catch reflects the same composition of the population o in the sea.

2. If in catches during intensive netting operations, there is an absence or a decrease in the relative numbers of the older age groups and an increase in the relative numbers of young, this means that the structure of the population has begun to change under the impact of the commercial whaling industry; on the other hand, one can judge the effect of the industry

on the population, i.e. on the stocks, by the magnitude of these changes. The latter situation is dependent on the fact that within a population the animals of the older age groups are represented by the least number of individuals. Thus in mass commercial whaling operations any overexertion on its part is bound to have a disastrous effect primarily on the older age groups.

However, I was able to isolate at the time only two age groups within the males and females: the sexually immature and the sexually mature, since I only had linear measurements of the animals at my disposal. In addition *199 to that, it is quite clear that a more detailed division of the sexually mature portion of the catches was unnecessary for it is here that one should look for those changes which could occur under the impact of the industry. Thus, this work, as I have already indicated (1951a), demonstrated only the accuracy of the basic premises but could not provide a sufficiently refined method.

It must be said that the method for determining the age of marine animals has begun to attract the attention of researchers only recently. Growth, for example, in cetaceans after the onset of sexual maturity slows down but does not stop; some animals growing more intensely, others less. Accordingly, Peterson's curves (1895) give distinct groups based on the number of years only within the sexually immature portions of the stock.

For pinnipeds, Chapskii (1951a, 1952a, 1952) proposes a method for determining age on the bases of the claws, and R. Laws - on the cross-section of the teeth.

For baleen whales, Tomilin proposed a method for determining the age on the bases of the whalebone. Dorofeev and Klumov (1935a) developed a method for determining age in the beluga according to the color of the animal which changes during the post-embryonal development of the animal. This feature allowed the authors to establish only four age groups: underyearlings, animals of the age of one to two years, from two to three years and three years and older. In other words, it is not possible to determine the age of the animals within the sexually mature portion of the stock with this method and consequently, it does not enlarge those limits within which the determination of age is possible even with the aid of Peterson's curves (1895).

A very interesting and original method of determining age in whales was developed in the scientific works of the Antarctic expedition "Discovery". I have in mind the works of Mackintosh and Wheeler (1929), Wheeler (1934) and Laurie (1937). This method is based on the periodical activity of the gonads in the females and on the traces that this activity leaves on the ovaries in the form of corpora lutea of pregnancy and the scars from them.

In place of the ruptured graafian follicle, as is well-known, a yellow body forms in the ovary. If after ovulation fertilization does not occur, then the yellow body of ovulation or false yellow body is quickly resorbed. If fertilization does occur, the yellow body or corpus luteum turns into a true corpus luteum of pregnancy which persists throughout the entire gestation period, and in some animals throughout the subsequent period of lactation. After resorption of the corpus luteum, a scar (corpus candicans) remains in its place.[1]

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[1] Trans. note: Evidently the author is referring to corpora lutea ovulationis and corpora lutea graviditatis - the author's "false corpora lutea" and "corpora lutea of pregnancy", respectively - one comes across in the literature in this regard. With respect to the term "corpus candicans" which the author uses to refer to the corpora lutea graviditatis scars it is presumably synonymous to corpus albicans which seems to be the only term used in the literature in this respect and , it seems, the only term cited in the

Judging by the works of the "Discovery" expedition, the corpus luteum in whales is resorbed very slowly because the author had occasion to come across up to 30 corpora lutea on the ovaries of a single specimen. These formations were in various stages of regression but only one functioning corpus luteum was always found. Basing themselves on the number of corpora lutea, the authors approach the determination of the age of the whales. An attempt by Comrie (1937-1938) to apply this method for determining the age of a false killer whale was unsuccessful. The author described the very unique shape of the corpus luteum which had the appearance of a cap of a mushroom seated on a stalk which protrudes from the ovary. The author was evidently unsuccessful in determining the age of the animal. Thus, for example, Comrie determines the age of one specimen with an interval of 16 years (from 4 to 20 years). In another specimen, the interval was 9 years and so on. It is quite evident that these intervals are so great that such a determination of age in animals has no practical significance. *200

For toothed cetaceans, this method was successfully applied by Sleptsov (1940a) for determining the age of the Black Sea common dolphin. The author demonstrated that in the dolphin the corpus luteum ovulationis does not leave any traces on the ovary after resorption while the corpus luteum graviditatis leaves a distinctly visible trace in the form of a scar persisting practically throughout the entire life of the dolphin. There is always only one corpus luteum. Consequently, every scar on the ovaries is evidence of previous births. Knowing the times of the onset of sexual

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dictionaries, medical or otherwise, to refer to corpora lutea scars. Incidentally, it is interesting to note that Websters (2nd ed.) gives the meaning "mamillary body - two small rounded eminences on the undersurface of the brain behind the tuber cinereum, forming terminals of the anterior pillars of the fornix: corpora albicantia," for the term corpus albicans. Perhaps this is an older term used to differentiate the two since both "albicans" and "candicans" essentially mean the same thing - from L. candicans, pres. part. of candicare " to be whitish"; albicams, pres. part. of albicare "be white".

maturity and the periodicity of calving in the common dolphin, Sleptsov (1940a) determines the age of the animals by the number of scars on the ovaries. The maximum number of scars that he found was 12.

Knowing that sexual maturity in the common dolphin females begins in the third year, that gestation lasts for 11 months and that the females bear young 3 years in succession and remain barren during the fourth year, Sleptsov gives the following table of the correlation between the scars on the ovaries and the age of the animal.(Table 41).

Table 41

Correlation between the number of scars and the age of the animals (by M. M. Sleptsov, 1940a, p. 48).

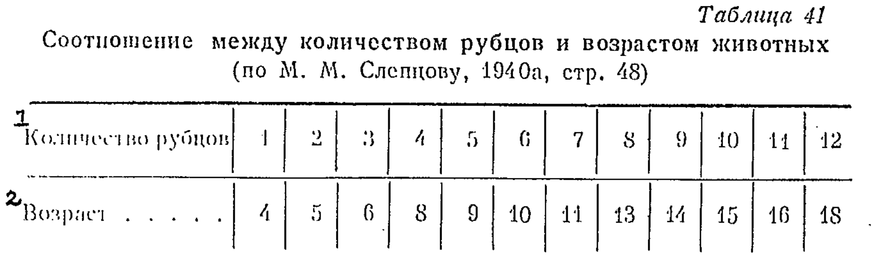

Таблица 41

Соотношение между количеством рубцов и возрастом животных (по М. М. Слепцову, 1940а, стр. 48)

1 Количество рубцов	1	2	3	4	5	6	7	8	9	10	11	12
2 Возраст	4	5	6	8	9	10	11	13	14	15	16	18

<u>Key to Table 41</u>:

1) No. of scars 2) Age

It seems to me that this Table requires certain adjustments. If one considers that the females bear offspring 3 years in succession and remain barren during the fourth year, then for females with 7 scars on the ovaries the age should be not 11, but 12 years; with 10 scars - 16 years and with 11 scars - 17 years. Moreover, one has to take into consideration the fact the periodicity in the reproduction of old females can be somewhat different than in the young ones. *201

Рис. 49. Яичники дельфина (оригин.):

1 — инфантильной самки; 2 — яичник с желтым телом беременности; 3 - то же и с рубцами; 4 — яичник с рубцами.

Fig. 49. Ovaries of a dolphin (origin.):

<u>Key to Fig. 49:</u>

1) Infantile female 2) Ovary with a corpus luteum graviditatis

3) Same as 2 including scars as well 4) An ovary with scars.

On the basis of the figures he presented, Sleptsov (1940a) concludes that "the life span of female dolphins does not exceed 18-20 years. If the females lived longer, then of course, there would have been more scars on the ovaries, but since the number of scars is limited to 11-12, then it can be considered that approaching 20 years the females stop bearing young due to advancing old age" (p. 48). This conclusion is not correct which will be evident from later discussion.

That interest, which the possibility of applying this method for determining the changes occurring in the age structure of a population under the impact of industry, i.e. for estimating the state of the stocks, aroused in me is quite natural. It was precisely with this aim that in 1939 we undertook the collection of common dolphin ovaries so that we would be able to follow the changes in the composition of the population under the impact of the industry in the succeeding years by means of the collection of material and the data obtained.

This study, as I have already indicated (1945), showed, in confirmation of Sleptsov's data (1940a), the extreme clarity of the scars on the ovaries from previous corpora lutea graviditatis (see Fig. 49), and also the systematically accurate distribution of females with a given number of scars on the ovaries.

The year 1939 was a year following a year of intense commercial whaling operations. From 1941 to 1945 on account of the war, there were no commercial dolphin operations. The interest which the comparison of *201 material for the year 1939 with the data obtained for that purpose in 1946, when in Yalta and on Utrish, 1516 pairs of common dolphin ovaries were collected, is understandable.

Table 42

Number of females with differing numbers of scars on the ovaries (in % to the total number)

Количество самок с различным

Part 1 (в % к общему

Years Годы	1. No. of Scars on the ovaries Число рубцов 0	1	2	3	4	5	6	7
A. All of the females A. Все								
1939	63,85	6,12	5,09	5,10	4,52	4,37	3,94	2,77
1946	50,46	7,58	7,39	6,93	6,53	6,20	4,82	3,36
B. Parous females Б. Рожавшие								
1939	—	16,93	15,72	14,11	12,50	12,10	10,89	7,66
1946	—	15,31	14,91	13,98	13,18	12,52	9,73	6,79

Таблица 42

числом рубцов на яичниках

Part 2

на яичниках 1. No. of Scars on the ovaries

8	9	10	11	12	13	14	15	16	n
самки A. All of the females									
1,60	1,02	0,29	0,29	0,29	0,15	0,00	0,00	0,00	686
2,31	1,32	0,79	0,73	0,59	0,20	0,33	0,26	0,20	1516
самки B. Parous females									
4,43	2,83	0,81	0,81	0,81	0,40	0,00	0,00	0,00	248
4,67	2,66	1,60	1,46	1,20	0,40	0,66	0,53	0,40	751

Key to Table 42:

1) Number of scars on the ovaries A) All of the females B) Parous females

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This material in comparison with the data for the year 1939 is presented in Fig. 50 and Table 42. Let us dwell on some general conclusions from the presented data.

1) The shape of the curves on the graph for both years allows us to conclude that we are dealing with characteristic "fading" curves which determine the age composition of females in the population. This not only confirms the validity of Sleptsov's (1940a) conclusions regarding the expediency of using this method for determining the age of the dolphin but confirms as well that with intensive netting operations, the age composition of the catches reflects the age constitution of the population.

2) It can be seen on Fig. 50 and Table 42 that in 1946, after the shutdown, the number of non-parous females in the catches was considerably smaller than in 1939, prior to the shut-down. During the same period in 1946, appearing in the catch was a group of old females with 14, 14 and 16 scars which were completely absent in 1939. As a result, under the influence

of a five year absence of commercial operations, the relative number of young animals in the catch decreased and the group of old females appeared which had dropped out under the impact of the commercial operations prior to the shut-down.

3) In part 1 of Table (B) it can be seen that the relative numbers of females with a given number of scars on the ovaries for both years are very close which confirms the accuracy of the first conclusion. In Part 2 of this Table, i.e. within the older individuals, it can be seen that in 1946, considerably more of them were caught than in 1939 prior to the shut-down.

4) Conclusions 2 and 3 permit one to conclude that under the five year shut-down the stocks of dolphins in the sea grew considerably, which is corroborated as well by air reconnaissance data so kindly imparted to me by A. P. Golenchenko.

As a result, it can be considered as established that the method used accurately registers the changes in the age constitution of the population occurring under the impact of the commercial industry and hence, that it is totally suitable as an easily realizable control over the state of the stocks of dolphins in the sea. Its regular application would make it possible to keep an eye on the impact of the indusrty on the population and to estimate the state of the stocks of animals.

This method which I presented at the Second Conference on Ecology in Kiev (1951a) was endorsed by it.

It is interesting to note a factor also pointed out by Sleptsov (1940a). In the majority of cases the scars are concentrated on the left ovary. Ocurring very frequently are females having up to 10 scars on the left ovary with a completely infantile condition of the right ovary, i.e. the embryo develops for the most part in the left horn of the uterus. It is difficult for the time being to explain such an asymmetry in pregnancy in a bicornuate uterus. It is possible that this is connected with the nature of locomotion of the dolphin. In this case, the physicists have to explain this enigma. *204

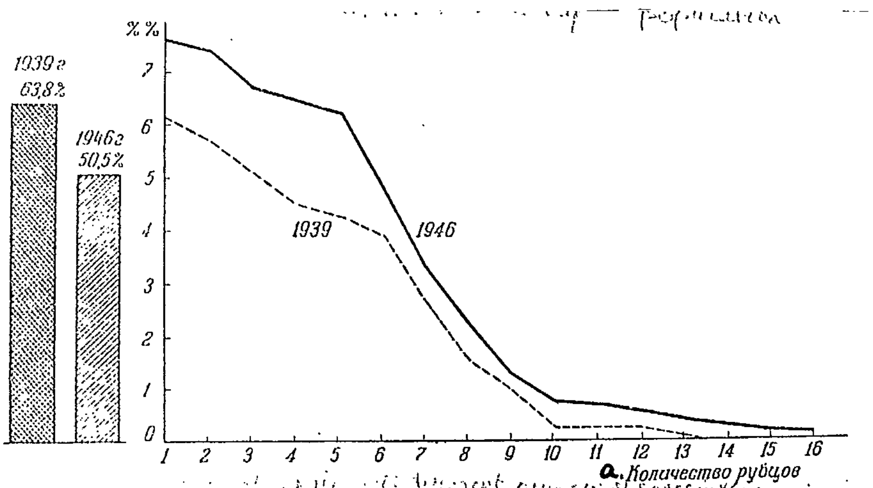

Рис. 50. Распределение самок с различным числом рубцов на яичниках в уловах за 1939 и 1946 гг. Слева — количество нерожавших самок (в %).

Figure 50. The distribution of females with differing numbers of scars on the ovaries for the years 1939 and 1946.

<u>Key to Table 50</u>:

On the left - the number of non-parous females (in %).

a) Number of scars

Sleptsov (1940a), considering that the maximum number of scars on the ovaries cannot exceed 12, limits the life span of the dolphin to a period of 18-20 years. The author obviously did not consider the influence of the industry on the population, due to whose effect the older females with a large number of scars on the ovaries can drop put. Then the maximum number of scars can exceed the one established by Sleptsov. Our material for 1946 confirms this conclusion. Proceeding from this fact and following Sleptsov's calculations, the life span of the dolphin can be fixed at a period of 25-30 years.

Obviously, one can consider that the stated method permits not only a continuing control of the state of the stocks of animals in the sea but also makes it possible to establish the basic factors necessary for the clarification of the nature of the population dynamics of the common dolphin (see the first section of this Chapter): 1) the life span of the animal and 2) the number of births in the course of a life time, i.e. the intensity of reproduction. If we know the third requisite factor as well, i.e. the natural mortality coefficient, then by means of this method we could approach the clarification of the mechanisms of population dynamics of this dolphin as well.

CHAPTER V

THE BIOLOGICAL FOUNDATIONS OF THE DOLPHIN-CATCHING INDUSTRY IN THE BLACK SEA AND THE SEA OF AZOV

1. A BRIEF SURVEY OF THE HISTORY OF THE DEVELOPMENT OF THE HUNTING INDUSTRY IN THE BASIN

It is very difficult to establish the emergence of the industry involving the Black Sea dolphins. Judging by the gypsum representations of the dolphin by the Greeks published by V. Yu. Marti (1941), these animals were known in the Crimea as far back as the period of the Hellenic culture. *205

The first authentic data on the dolphins belong to G. Hablizl (1785).

Some information regarding an industry involving these animals are given for the first time by Averkiev (1866), who, describing the industry which involved the shooting of the animals conducted by numerous Turkish dolphin fishermen (more than 30 crews) from boats near the Pitsunda coast and near the mouth of the River Bzyba, notes that "sometimes they hunt them by other means: they surround the area where a school of dolphin passes through with a long net and from small boats kill the dolphin trapped by the net with gaffs", and that "the yield of a summer's kill of dolphin in the Pitsunda fortification consists of no less than 3000 poods of fat" (No.77, p. 355).

Somewhat later N. Ya. Danilevskii (1871), describing the catching of dolphins with fixed nets, noted that the proportions of this industry are not large "even in the Black Sea where there are many of them (dolphins - S. K.)" (p. 209).

The shooting of the dolphins by the Turkish dolphin fishermen from oared feluccas coming into the waters of the Caucasian coast for this purpose, is described by B. Poznanski (1880).

After that, N. and V. Köppen (1883) wrote on the catching of dolphin in our waters by Anatolian, Trabzon and Sinop dolphin fishermen, later selling the fat in our coastal towns.

The first works entirely devoted to the description of the catching of dolphin in the Black Sea belong to A. Arnold, N. Borodin and P. Il'in. *206

Arnold in his small work (1896) based on information obtained from questionnaires, touches on the distribution of the industry, its organization, rendering of the blubber and its sale. Of great interest is his second work (1910) where a successful attempt in the application of the fat of the dolphin jaws, subjected to a special processing, for lubricating chronometers is discussed.

Borodin (1902) wrote that "dolphins are killed mainly with guns" (p. 913). Il'in (1903) presented a very reliable and detailed account of the technique of dolphin shooting.

The catching of dolphins near the Caucasian coast was dealt with most fully by Silant'ev (1903) who gave a detailed description of the methods used in the industry and its organization, the rendering of the blubber, performed in those days by Turkish dolphin fishermen in kettles on the shore, the size of catches, and also on the basis of factual material which he personally collected, he set out conditions directed at regulating the industry near the Caucasian coast.

A later description of the catching of dolphin by P. Porfir'ev et al. (1904) repeats Silant'ev (1903) to such a degree that Dinnik (1910), quoting Silant'ev, writes in a footnote on p. 11 :"This very article was carried in the journal "Nature and Hunting" under the signature of Porfir'ev, Petrov, Kurakova and Stepanova".

Two small articles by P. Dmitriev (1914) and K. A. Satunin (1914) appeared at the beginning of the First World War. Of greatest interest is the article by Dmitriev who, noting that "with very little exceptions, Anatolian Turks were engaged in the dolphin industry on the Black Sea" (p. 22), also indicated here where the industry took place along the coast which were Pitsunda, Gagri, Sochi, Adler and Gelendzhik, and in the Crimea - Balaclava, where mainly Greeks were engaged in the dolphin industry.

Dmitriev (1914) describes the net catching of dolphin carried simultaneously from 20-40 oared feluccas having on board from 10-20 nets with a length of 10-30 sazen each and a width of about 4-5 sazen. The feluccas surround the school of dolphin and "let out the nets adrift one behind the other, forming three circles" (p. 32). This catch, according to the author's testimony was carried out "3-5 miles, but no farther than 12 miles offshore, and even then in exceptional cases. In a good catch, they capture up to 100 head of dolphin at a time; for the most part from 10 to 25 head" (p. 23). *207
Further on, the dressing of the animals, the rendering of the blubber are described and the prices for the blubber oil are quoted.

Satunin (1914) confines himself to a reference to Silant'ev (1903) work concerning the technology of the industry. On the other hand, touching on the conditions of the industry, he writes that the Turkish dolphin fishermen in Pitsunda create unbearable living conditions for the summer residents and the indigenous population: rendering blubber on the shores, they discard here the flayed carcasses and other waste products of the industry. Satunin proposes to isolate the dolphin operations to a "special receiving point" and to authorize the dressing of the animals and the rendering of the blubber "only in a small number of points" (p. 236).

The First World War and subsequently the civil war interrupted for a long time both the industry as well as every type of research on the Black Sea basin.

Thus the commercial Black Sea dolphin industry in pre-revolutionary Russia, as we can see, saw absolutely no development. The situation remained unchanged up to the beginning of the XX century. The entire industry was farmed out to the Turkish dolphin fishermen who carried on the industry on a very small scale. Even more primitive and unsanitary was the way in which the products of the industry were processed. Despite the fact that Silant'ev (1903), having studied the industry on a special commission from the Department of Agriculture, urgently recommended its regulation, the situation, as is evident from Satunin's (1914) note, did not change absolutely. As a result, the draft of the regulations for conducting the industry proposed by Silant'ev remained unrealized.

Touching superficially on the development of the industry in other countries bordering on the Black Sea, I will only note that, judging by the pre-war years (1934-1938), the industry was developed to a lesser degree in Rumania and Bulgaria, and to a greater degree in Turkey. However, the catch of all of these countries taken together was less than half of that of our present-day industry, which is evident for T. S. Rass' data (1949).

The industry, after a prolonged interruption, began to revive in our country only during the Soviet period. V. M. Kozlov (1921), noting that there had been no catching of dolphin for seven years already, particularly emphasizes those prospects which he has regarding the abundant production of fats, meat and skins, which our country so desperately required at the time.

Vodyanitskii (1923) also wrote on the economic prospects of the dolphin industry on the Black Sea, stressing attention on a thorough utilization of the products of the industry. "At the present time," he wrote, "we have learned to make canned foods out of the meat. The reprocessing of the blubber, carried out industrially, produces a highly valuable product. This matter is not easy from the organizational point of view, but is pregnant with large economic benefits" (p. 247). *208

An engineer, V. Shikhov (1923), also wrote on the economic advantages of a dolphin industry, having proposed a plan for two factories for the processing of the products of the industry. Describing various catching methods and calculating their potential proportions, Shikhov (1923), incidentally, reports that "the Germans, during their sojourn in the Crimea, even killed the dolphin with machine guns; the carcasses they canned and sent away to Germany and Sevastopol where they had equipped a factory for this purpose" (p. 9).

The catching of dolphin began anew in our country only in 1920 when primary processing stations were organized in the Crimea and in the Caucasus. However, in those times it was necessary to employ the services of Turkish and Greek "specialists" as a result of which the industry was conducted on such a small scale and was so inefficient that it became necessary to close the organized points shortly thereafter. In 1924, the dolphin industry was under the management of the Gostorg (The State Export and Import Co.) and in 1928 was transferred to the management of the Azchergosrybtrest (The Azov-Black Sea State Fisheries Trust). In 1931, the dolphin industry was combined into the Soyuzmorzverprom (The State Federation of Marine Animal Industries), and thereafter, under the direction of the USSR Commercial Fisheries (Ts. B. Okuneva, 1934).

In 1929 in the Crimea, the first artel of Soviet commercial dolphin industry workers was organized. From this time on a vigorous growth of the dolphin industry in the Azov-Black Sea basin begins which went two routes: along a line of the development of a state industry, the so-called "goslov" (state fishing) and along a line of an artel originally, and later, a state fishing industry.

Gradually new artels of commercial dolphin industry workers were arising. New primary processing stations for the products of the industry and specialized, technologically equipped processing plants were being built, the equipping of which permitted full utilization of the raw material right up to the preparation of meat-bone meal and fertilizer. Permanent blubber rendering and processing plants in Tuapse, Balaclava and the floating factory ship "Krasnyi Kubanets" were built. Later, processing plants were built in Novii Afon and Novorossiisk, and a primary processing plant in Yalta.

An author, concealing his identity under the initials G. S. (1929, 1930) describes the processing of the products of the industry, mainly the blubber at the Tuapse factory and on the "Krasnyi Kubanets". The technological aspect of the matter is dealt with in sufficient depth and generally accurately, but in the description of the dolphins and their biology, there are areas which distort the facts and are unacceptable for specialized publications.

Detailed descriptions of methods for deriving medicinal and industrial oils from the fat of the dolphins and the preparation of meat-bone meal and fertilizers at the Tuapse and Sevastopol factories and on the "Krasnyi Kubanets" are given by V. Kolchev (1931). The author indicates means of improving this production and quite correctly directs attention to the necessity of organizing the production of the fat of the head of the dolphin *209 separately from the other processes which, similar to the products of the processing of the Far Eastern beluga, can be of a very high quality.

The excellent qualities of the industrial dolphin oil subjected to chemical analyses conducted by N. Dionis'ev (1929). S. Matsko (1931), Lepskii, Egorova and Mikhlina (1931), showed that the medicinal dolphin oil is noted for its high content of anti-rachitic Vitamin D. Mal'm also wrote on the medicinal properties of this oil (1932) and called it "delphinol". The author directed attention to the fact that "besides the blubber, the skin of dolphin after factory processing, gives a good quality leather. The skeleton goes for the manufacturing of fertilizers, and the meat during the winter time - for canned goods and sausage products" (p. 20).

A detailed account of all the phases of the technology involved in the processing of the products of the industry is given by A. S. Kravenchko (1932).

Concerning the literature on the technology of the processing of the products of the dolphin industry, it is necessary to note a thorough and very reliable study by Ts. B. Okuneva (1934). Her work is replete with factual material. She presents weight tables of the various parts of the body of all three species of dolphin; the result of a chemical analysis of the subcutaneous, head and jaw oils, the meat, brain, tongue, liver, heart, lungs and kidneys of the different species of dolphin; the chemical composition of the blood, intestine, fins; described are methods of reprocessing of the dolphin carcasses, and a chemical analysis of the finished product is given. "As a result of observations and studies," writes the author, "it can be maintained that all of the composite parts of the dolphin can be utilized. Of the products obtained from the dolphin, the body fat, which at the present time is the basic product of the industry used for the derivation of medicinal and industrial oils, is the most significant.

Lately, the medicinal oil has received wide application as a medicinal remedy, replacing cod liver oil. The industrial oil enjoys sufficient demand in the tanning, soap manufacturing and other industries" (p. 118).

It is understandable that I cannot delve into the details of the processing technology of the products of the industry here. I presented *210 these data only in order to show how thoroughly the products of the industry were utilized at the time. Unfortunately, the present situation in this regard is unsatisfactory, on which we will dwell in more detail in the following section.

Elaboration of the technology of the processing of the raw material and the output of high quality products stimulated further development of the industry.

The industry operated practically the whole year round. From January to May, it was concentrated near the southern coast of the Caucasus, and from June to October, and sometimes November - in the north-eastern section of the Black Sea. Such a dislocation is explained by the distribution and the migrations of the main concentrations of the dolphins.

The industry followed two trends: the seine net catching was being developed and existing simultaneously with it was the attack method, the so-called shooting method.

In addition to that, the drag-net dolphin catching operations, used only for catching the harbour porpoise in the southern section of the Sea of Azov and the Kerch Strait, were also conducted. P. K. Gudimovich (1936) describes the successful use of fixed gill nets for catching dolphin on the

Black Sea. However, the relative significance of these types of operations in the total catch of Black Sea dolphins comprised a negligible portion. The principal modes of taking dolphin were the seine net and the shooting operations.

The lätter mode was studied by me in 1935 in the regions of Batumi and Novorossiisk (1941). I came to a conclusion regarding the unsuitability of its use because of the excessive number of wounded and killed sinking and consequently lost to the industry. On the basis of this study, the shooting of dolphin in the Black Sea was prohibited by a decree from the Glavrybvod (The Bureau of Fisheries Admininstration). Thus, from 1936 only one steadily developing seine net method of catching dolphin existed.

The development of our commercial dolphin catching industry on the Black Sea attracted the attention of foreigners. Thus, H. Steinert (1929) described it in sufficient detail with indications to the primary commercial dolphin catching regions with catch statistics on each region and even indications of prospects for development. Simultaneously, similar articles appeared in a German journal (Die Gewinnung von Delphinthral in Russland, 1929) and in France (La chasseau douphin, 1929).

What is seine net fishing and how is it conducted? It goes without saying that a detailed treatment is outside of my present objectives, since the technology of this matter has already been described (see for example N. P. Tatarinov and N.A. Eremeev, 1936; Yu. Yu. Marti, 1936; S. Yu. Freiman and S. K. Kleinenberg, 1939; Yu. T. Gubenko, 1952, and others). I will therefore confine myself to a general outline, having directed those interested in the method to the specialized literature. *211

The seine net for catching dolphin is a large net used along the principal of a purse seine. The length of the seine net is around 500 m with an average depth of about 60 m. There are seine nets which are larger, and smaller ones as well. The fleet of a single seine net brigade consists of 2-3 motorized vessels (earlier - launches; now - seiners and launches) and 9-11 feluccas (row boats). At first, the seine net lay in one of the feluccas which was called the "mother-ship". The seine net was "broken out" from this boat and it was gathered into it, These labor-consuming processes were conducted manually. Now they are mechanized and the seine net is deposited not in a row boat but in the stern of the seiner. There are usually 34-35 men employed in one brigade, not counting the crew of the motor launches. Before the mechanization of the commercial dolphin industry, this number sometimes went as high as 55 men. Thus, a seine net brigade is a rather powerful organized body.

Upon departure into the sea and upon return, the rowboats are towed by the motorized vessels. Usually, several rowboats are attached to each vessel. Having located a school of dolphin, it is surrounded from two sides while the tow ropes of the row boats are alternately loosened as a result of which the school is encircled by the fleet. The seine net is "broken out." This operation must be carried out with the maximum of speed. When the seine net is "broken out", then on a signal from the brigade foreman, the drive of the school into the semicircle formed by the seine net begins. At this time, and during the time the school is detained within the encirclement, various sound effects are produced: gun shots, striking the side of the boats and the "telephone" which we have already discussed in the second chapter. The drive proceeds in concord with the entire fleet, a great amount of experience and skill on the part of all the brigade members being required considering the rapidity of movement of the common dolphin; the slightest blunder and the entire encircled school can be allowed to slip out (see Fig. 51).

When the school is in the seine net, the ends of the latter are drawn in following which the bottom line is drawn in, closing the seine net (see Fig. 52).

When the seine net is pursed, picking the dolphin out of the water into the row baots, usually manually, begins. Following this, the animals are reloaded onto the launches at the end of the catching day and together with the brigade are transported to a primary processing station of the catches where the animals are dressed. If there are many dolphins in the sea, then one launch is occupied with transporting the catch while the other two motor vessels continue the catch. In this case, it is necessary to have three motorized vessels per brigade.

The reader may get the impression that seine net catching is unjustifiably and extremely cumbersome. This form of dolphin catching is of course cumbersome but it is very productive in return. Cases where several hundred *212 animals are caught in a single set of a seine net are not infrequent. If the fact that a brigade can make several sets in the course of a day under good catch conditions is taken into consideration, then the efficiency of such a catching method becomes clear.

The seine net method of catching the common dolphin, although it is hampered by the rapidity of the movement of these animals, on the other hand it becomes easier in return, since the school is always in sight which alleviates the catching conditions. Thus is explained by the fact that in comparison with the other Azov-Black Sea dolphins, the common dolphin, due to a short respiratory pause, cannot dive for any length of time.

The situation is different with the catching of the bottlenose and the harbour porpoise which in contrast to the common dolphin are always caught only in the littoral zone.

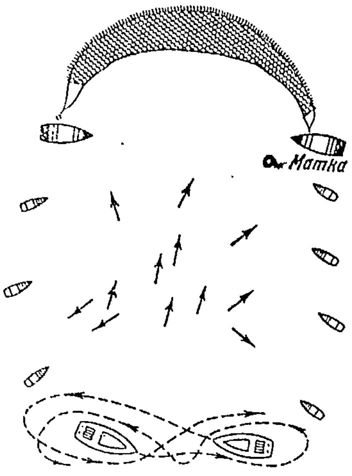

Рис. 51. Схема расстановки судов при загоне дельфинов в невод (по Н. Е. Татаринову и Н. А. Еремееву).

Fig. 54. Diagram of the disposition of the vessels while dolphins are being driven into the seine net (by N.E. Tatarinov and N.A. Eremeev). a) Mother-ship.

The bottlenose, due to its capacity for long dives, slips out easily and unnoticed out of the encirclement by the fleet. I have often witnessed how an encircled school of bottlenoses suddenly disappeared even while the seine net had already been "broken out" and only several animals were caught in the seine net - and at times, not a single animal was caught. Catching the bottlenose requires special proficiency and skill on the part of the entire brigade, especially the brigade foreman. It is because of this fact that only a few brigade foremen mastered the catching of this animal.

Seine net catching of the harbour porpoise is conducted in a completely different manner. This dolphin, as was already noted, is usually dispersed, not forming schools. Therefore, before beginning the encirclement, the catching fleet, having formed itself into a chain parallel to the coastline, advances in a frontal movement towards the shore, gradually herding the animals in this way. Following this, the flanking lines of the fleet, advancing forward, for a circle out of the chain of the fleet which also gradually decreases in diameter. It is only after this that the seine net is "broken out" and the subsequent operation of the catch differs little from the usual. While great speed is required for catching the common dolphin, in the catching of the harbour porpoise, the entire operation proceeds relatively slowly for the animals themselves move slowly. *213

The dispersed conditions in which the harbour porpoise is found and its visibility on the surface of the water in comparison with the common dolphin are extremely contrasting. I can recall when I had occasion to become acquainted with the catching of the harbour porpoise for the first time in the Anapa region after repeated observations of the catching of the common dolphin. When the fleet began to form the circle, I saw only solitary dolphins which had appeared on the surface of the water a long way from one another on the entire great expanse of the circle. Sometimes a group of 3-5 specimens would show itself. It seemed to me that throughout the entire area, barely more than 50 animals could be seen; how great was my astonishment when 532 animals were pulled out of the seine net.

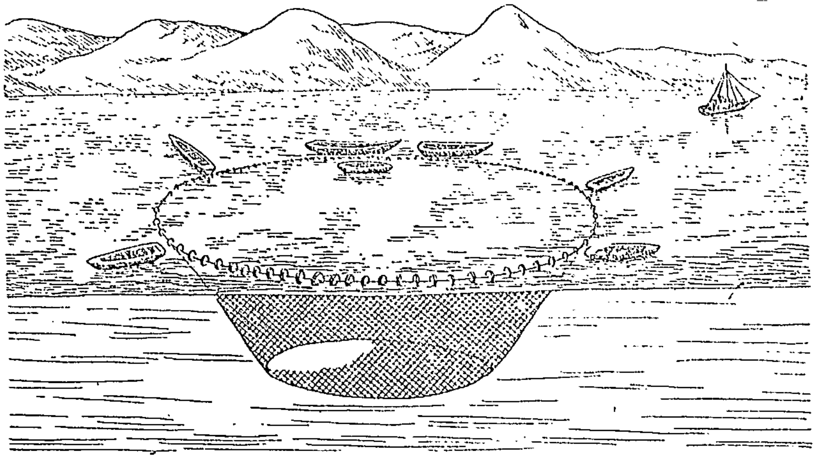

Рис. 52. Схема замкнутого невода
(по Н. П. Татаринову и Н. А. Еремееву).

Fig. 52. Diagram of a closed seine net (by N. P. Tatarinov and N.A. Eremeev).

It stands to reason that the organization and technology of seine net catching were being improved in the process of the development of the trade. Regarding its organization, Kravchenko (1932) had already quite correctly noted: "The creation of special dolphin brigades within the fishermens' collectives as it is presently practiced, still in no way resolves, but only obscures the basic problem - the organization of a large scale dolphin industry on the Black Sea on the basis of a state industry and special collectives for catching dolphin" (p. 79). It was precisely the development of a "goslov" [state dolphin catching enterprise - Trans.] which was in fact the factor that determined the further development of the seine net industry.

Mal'm (1931, 1932), having written on the necessity of the intensification and rationalization of the Black Sea dolphin industry, quite correctly noted that "from the point of view of an efficient catching of dolphin, the <u>aloman</u>[1] method of catching is the most suitable" (E. N. Mal'm, 1932, p. 21). M. T. Khailov (1932), considering that the highest rates of development of the marine mammal industry fall on the Far East and the Black Sea, notes: "On the Black Sea, the trend of development follows along the lines of an increase in the motorized fleet and the construction of launches for the dolphin industry" (p. 5). Establsihing the growth of the take in the Black Sea dolphins, Freiman (1931) indicated that "even here, the catching techniques, based on taking by means of the <u>aloman</u> and shooting from skiffs is inadequate for the maximum utilization of the raw material. Catching with seine nets [<u>aloman</u> - Trans.], being the principal method, is built around the manual set of the seine net and is heavily dependent on the weather: in wind forces of 3-4, setting of the seine net is already impossible. The Azov-Black Sea Fisheries Station is presently working on the problem regarding the modernization of the Black Sea dolphin industry" (pp. 54-55). *214

Danilevskii (1932) improved the mechanization of hauling in the seine net which allowed it to be hauled in and the bottom line to be recovered

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[1] <u>Alomanyi</u> catching is seine net catching. "<u>Aloman</u>" is a Turkish name for a seine net used in the catching of dolphins.

with the aid of motorized vessels participating in the catch. Due to these changes, the time for recovering the aloman was shortened to 10-15 minutes, and the entire operation of the catch 1 1/2 hours rather than 2 1/2 - 3 hours; this made it possible to increase the number of daily sets in a working day by roughly 2 to 5 and made it possible to conduct catches in such strong currents as are found, for example in the Batumi region.

The number of workers with such mechanization was reduced from 55 to 40-45 men and the number of row boats to 8-9 (p. 29).

The use of the circular seine using a seiner brought the greatest results into the mechanization of the seine net industry which decreased considerably the dependency of the industry on the weather. N. A. Eremeev (1936) wrote the following in this regard: "On the Black Sea, the weak spot in the entire dolphin affair is the output. The contemplated course of transition from the existing aloman outfits to actively catching vessels will make it possible to break away from the shore; be less dependent on the sea conditions and the weather" (p. 22). In another article by the same author (N. A. Eremeev, 1936a, p. 12), it was indicated that "experiments in using a small seiner with a circular seine net [aloman - Trans.] conducted last year produced positive results which prompted the Krymgosrybtrest (The Crimean State Fisheries Trust) to divert the seiners 'Andrianov' and the 'Delphin' to catching dolphins in the Feodosiya region".

According to Marti (1936), the utilization of a seiner with a circular *215 seine net, as we have already seen from Eremeev's (1936a) article cited above, having already been introduced into commercial dolphin catching, accelerates the work of the entire unit due to the reduction of the row boats; permits catching during heavy swells; decreases the effect of currents on the seine net; accelerates the phases of the catch; increases the catching efficiency by 50%; reduces the number of dolphin fishermen by 25%; increases the output per man-hour by 35% and increases the earnings of the fishermen by 10%. It is clear from the above what an improvement the use of a seiner with a circular seine net brought into the technology of the seine net industry.

Beginning in 1936, aerial reconnaissance operations on the Black Sea began on a regular basis; at first under the supervision of V. I. Tsalkin and later, under A. P. Golenchenko. Its objectives, organization, the best hydrometeorological conditions for the conducting operations of, and its effectiveness for the industry, are described by Tsalkin (1937). The work of our aerial reconnaissance operations was reflected in the Bulgarian literature (C. A. C., 1946) where the author, citing our experiment, speaks of the benefits that could be derived from the organization of aerial reconnaissance operations in Bulgaria.

Thus 1936 was the year of change in the technological development of the commercial seine net operations. In this year, the use of a seiner with a circular seine net was developed and the same year saw the inception of aerial reconnaissance operations which directed the commercial dolphin catching brigades to concentrations of animals discovered in the sea. These measures increased sharply the catch of Black Sea dolphins in the succeeding years, especially in 1938.

The hostilities of 1941-1945 caused enormous damage to the fishing and hunting industries on the Black Sea. In 1946, the primary fish and dolphin processing stations in Anapa and the Crimea were completely restored.

In conclusion to this section, I would like to note the following.

The Soviet hunting industry on the Black Sea began in 1929, and by 1938, it had reached the highest point in its development.

Only 10 years were necessary in order to develop a new, technologically equipped branch of our hunting industry instead of a routine, small scale trade of many years standing farmed out to Turkish dolphin fishermen in pre-revolutionary Russia.

2. THE BIOLOGICAL BASES OF THE INDUSTRY AND THE PREREQUISITES FOR A RATIONAL EXPLOITATION OF THE NATURAL RESOURCES OF THE BASIN

And consequently, we have seen that the catching of the Azov-Black Sea dolphin had already attained its peak during the pre-war years. However it should be acknowledged that at the present time, the industry is still far from coning out of the decline in which it found itself after the *216 war.

Thus, for example, the catch level compared with the pre-war period, still continues to remain low. While the commercial season lasted almost the entire year round before the war (excluded were only November, December and part of January), at the present time, it already ends during the first half of September, having begun in April-May. It is only recently that the winter-spring catches have begun to revive near the southern coast of the Crimea, but the catch is still extremely small. Previously the bulk of the catch was made during the months of the doldrums (July and August), i.e. the least profitable months, a more detailed discussion of which will be given later.

During the first year of development of the industry, it was conducted exclusively in the littoral zone - not more than 10 miles offshore.

The use of a seiner allowed the industry to be transferred farther away from the shore. Now, the industry is again carried on mainly in the littoral zone, if several brigades are not considered. The development of the "goslov" during the post-war years in the Novorossiisk region, for example, quite definitely falls behind collective catching. Kravchenko's (1932) valid idea regarding the necessity of creating a state industry has already been presented in the preceding section. As experience has shown, it is precisely this concept that was of determinative significance in the development of the Black Sea dolphin industry; it is this concept that must be the underlying factor in a proper exploitation of the natural resources of the basin.

The state of the industry at the present time is such that it is quite opportune to pose a question regarding its proper organization. On the other hand, biological prerequisites, in our opinion, should first of all form the basis of a rational organization of the industry.

It stands to reason that those biological principles which we will be discussing, cannot be considered as ready-made prescriptions for the execution of the industry, for their realization will inevitably pose such problems of a technological nature whose solution is inconceivable without the participation of production engineers and technologists.

The first factor of a biological nature pointing to the necessity of an intensification of the industry at the present time, is <u>Skryabinaliosis</u> of the basic commercial species - the common dolphin. As had been noted in the second chapter, this extremely pathogenic disease is the most potent factor in the mortality of the animals.

It should be noted that up until the helminthological studies conducted by Delamure which were frequently discussed above, I had no answer to the question as to what besides the industry was a factor which limits *217 the abundance of the common dolphin in the Black Sea. Now the answer to that question is entirely clear. In light of S. A. Severtsov's (1940) view on the relationship of the parasite and the host, it can be concluded without any hesitation that the main eliminating factor for the Black Sea dolphins are the pulmonary helminths; namely, the nematode Skrjabinalius cryptocephalus Delamure, which having localized in the lungs, destroys them. Thus, the activity of the nematode, given the presence of large numbers of them, inevitably leads to the destruction of the host, which is demonstrated with complete obviousness by Delamure's studies (1951a, 1952, 1955). The adult, sexually mature animals are infested to a greater extent with this parasite, and the young, sexually immature to a lesser degree, i.e. the activity of the parasite affects mainly the reproducing portion of the stock.

Here, it can be noted that during the period of greatest pressure on the part of the industry, i.e. 1936-1939, there were never such numbers of this nematode as occurred in 1946 after a prolonged interruption in the industry when the common dolphin population in the Black Sea increased immensely. This only confirms a condition well-known in parasitology emphasized by V. A. Dogel' (1947), that when the population of the host increases, the population of the parasite progressively increases.

There is no doubt in the fact that this nematode limits the population of the common dolphin in the Black Sea and that the effect of this factor decreases only in conjunction with the thinning out of the dolphin population by industry. Delamure (1952) writes in this regard that the infestation of the external environment with the larvae of S. cryptocephalus in recent years (years of the decline in the industry) has increased and that in the future one can expect an even greater morbidity as a result of skryabinaliosis. In order to prevent an increase in the invasion and in order to improve the sanitary conditions of the dolphin stock, Delamure recommends the highest permissable intensification of the industry. This instruction by the author should be considered by our economic organizations.

Nevertheless, it does not follow from this that the industry can be taken to any proportion of catches. Given the present-day technology, such an arrangement could lead to a rapid depletion of the stocks of animals valuable in economic terms which is not in our interests which contradicts the principles of a rational economic system. We are talking about an intelligent intensification of the industry.

The economic organizations have a right to pose the question as to where exactly is this limit that can be used as a guide given further intensification of the industry. It would appear that initially, the level of catches for the year 1938 must be this limit. Later on, on the other hand, the method set out in the preceding chapter should be used as a continuing *218 control on the stocks of animals in the water body.

The application of the method is very simple. For this purpose, it is only necessary to collect and fix the ovaries of caught females which any observer, even one with little qualifications, can do during the dressing of the animals. The analysis of the material is also very simple and requires neither special qualifications nor apparatus for the scars and the corpora lutea on the ovaries are very distinctly visible (see Fig. 49). Thus, after the conclusion of the commercial dolphin season, the collected material can be processed in 2-3 months. Depending upon the picture that the analysis of the ovaries provides, it will be possible to plan the catch figures for the following commercial season. The continuous application of such a control is very simple to do, and in addition, it makes it possible to constantly keep an eye on the state of the stocks, and on the basis of this, to properly plan the catches.

In this way, the industry can be intensified without the risk of undermining the stocks of the animals.

Thus, the first conclusion to which we come on the basis of biological data consists in the fact that the industry, conducted within intelligent limits, has no detrimental effects on the population; on the contrary, it improves its sanitary conditions, decreasing the proportions of the natural mortality of the animals.

The following conclusion concerns the dispersion of the industry.

As was demonstrated above (see Chpts, II and III), the individual species of the Black Sea dolphin differ sharply from one another according to the type of feeding and according to the regions of distribution. The common dolphin, which has the greatest commercial significance, is an especially pelagic form, inhabiting practically the entire water area of the sea, forming in addition to this, huge stocks far from the shores. The bottlenose and harbour porpoise, basically benthonic forms, are distributed only in the littoral zone.

These differences in the distribution of the animals logically compels one to consider as advisable a different organization of the industry according to the species of the Black Sea dolphin as well. If it is expedient to base the industry of the bottlenose and the harbour porpoise on shore, then the common dolphin industry should be moved out into the open sea.

Cases are still frequent when brigades waste 12 and more hours each in order to deliver the catch to the base, during the course of which the seine lies idle. Cases such as the following, to which I have also been witness, occur as well. Aerial reconnaissance reports an accumulation of

dolphin discovered 50-60 miles offshore. The brigade proceeds to the indicated grid of the sea, but before it reaches the location, the dolphin have already left. The brigade spends the night at sea and with the break of dawn, having sailed around in vain searches for the dolphin, is forced to *219
return to base without any catch.

Similar cases, unfortunately are not infrequent. The absurdity of this is so obvious that in most recent years, as far as I know, they have begun to dress the animals at sea without returning to shore. Nevertheless, such an innovation is only a half-measure, especially that in connection with this the processing of the caught animals suffers, on which we will dwell in more detail later.

It is clear from the above discussion that the biology of the common dolphin determines the expediency in principle of a dispersion of the industry different from that of the littoral forms such as the harbour porpoise and the bottlenose. Thus, it is obvious that in the prospect for further development of the common dolphin industry, the creation of a floating base for the processing of the catches should be kept in mind. It is also obvious that it is not all obligatory that this base need always be only in the open sea; it must be near the place where the industry is concentrated at any given time, i.e. what is important is that it be able to move in the necessary direction since the experience of creating shore bases has already shown their incompetence. Thus for example, the excellently equipped plant at Novyi Afon usually operated only during the four spring months; with the move of the industry to the north-western section of the sea the plant was condemned to idleness.

This measure, freeing the industry from the tie with the shore, will make it possible to turn to the exploitation of the resources of the open sections of the sea, in which Borodin (1902) in conformity with the fishing industry sagaciously saw " a strong guarantee" of its further development in the Black Sea.

It stands to reason that the reorganization of the existing industry, and possibly the catching techniques in the direction of a complete freedom of the vessels from the row boats towed by them, should precede the realization of this measure. But this is already a problem for the production engineers.

The most economical location for basing the harbour porpoise industry is Anapa where this dolphin is presently being caught, or in Kerch. In the latter case, the base would serve not only the seine net, but the drag-net operations as well, which could become reactivated in the Kerch Strait and in the southern sections of the Sea of Azov.

A very small base for the bottlenose industry could be built in the Crimea, but only not in Yalta or some other health resort. This base could be built in Partenuta, Sudak or any other place.

Such a dispersion of bases by no means, of course, means that the industry, being based in Anapa for example, will catch only the harbour porpoise, completely skipping the other species of dolphin. We are not talking about a strict specialization of the industry, but about the crea- *220
tion of coastal bases in places where one or another species is caught more often, i.e. to prepare the foundation, although as was already mentioned in the preceding section, the technology for carrying out the industry of the individual species is specialized to a sufficient degree.

The following conclusion concerns the calendar periods of the industry.

It was indicated earlier that the largest portion of the catches occur in July and August. The basic product of the industry, as we know, is the subcutaneous blubber. In addition to that, July and August are exactly the time when the dolphins have the least amount of subcutaneous blubber (see Ch. II). The presented material indicated that a quite specific fatness dynamics in the dolphins is observed, following the same trend in different years and in the different regions of habitation of the animals, the period of maximum fatness of the animals being March-April and the minimum period being July-August. Beginning in September, the amount of fat in the animals begins to increase gradually (see Fig. 30). Let us corroborate this conclusion with average figures of commercial weights of the khorovina (blubber on the skin) for the various months, computed according to the data of the Yalta industry for the year (1948) (Table 43). The figures being presented are based on the weighing of hundreds of animals for each month and they can therefore be considered reliable.

Table 43

Mean weight of the khorovina of the common dolphin (in kg)

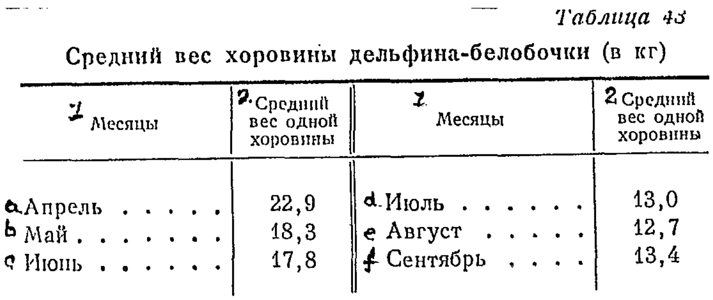

Таблица 43

Средний вес хоровины дельфина-белобочки (в кг)

1 Месяцы	2 Средний вес одной хоровины	1 Месяцы	2 Средний вес одной хоровины
a Апрель	22,9	d Июль	13,0
b Май	18,3	e Август	12,7
c Июнь	17,8	f Сентябрь	13,4

Key to Table 43:

1) Months 2) Mean weight of a single khorovina 1a) April 1b) May 1c) June 1d) July 1e) August 1f) September

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It can be seen from the Table that the animals have the least subcutaneous blubber precisely in July and August. A clearly paradoxical situation results; the height of the commercial season falls during the period least profitable from the point of view of the industry.

In April, and according to Fig. 30 one can say even March, the amount of blubber in a single animal is on the average 10 kg more than in July or August. If this difference is carried over to the entire catch obtained during the height of the industry, this will constitute an impressive figure. It is quite obvious that it is necessary to move the focus of the industry to the period of maximum fatnes of the animals, i.e. to March, April and May. *221

An objection can be raised here to the effect that July and August are the most convenient for the industry due to the prevailing calm weather during these months. To adhere to such a position is to follow the path of least resistance. Here again a question of a technological nature arises: how to reconstruct the seine net method in order to safeguard it against the detrimental effects of swells in the sea. The use of the seiner with a circular seine net has already, as we have seen, to a considerable degree rid the operation of the industry of this effect. Thus, this problem should not be taken as insoluble: it simply requires further refinement. If one takes into consideration that during the time of maximum fatness of the dolphins we obtain almost twice as much blubber, then it means that by moving the industry's focus to the most profitable period, we will obtain twice the amount of the basic product with the same catch proportions. It seems to me that this alone justifies the work necessary to reconstruct the seine net industry.

However, there is yet another factor which points to the necessity for reconsidering the periods of the commercial operations.

The dolphins reproduce (see Ch. II) mainly during the summer period. Their mating season falls in July and August with an extended period of mating from June to October. The period of calving extends from May to September with its peak in June and July. There is no doubt that conducting commercial operations during this period interferes with the animals' performance of these functions which are important to them. Particularly adverse in this respect can be the deep sea catching, the transition to which I had recommended earlier, since the period of mating and calving of the common dolphin is concentrated for the most part in the open sea.

Everything that has been discussed here inevitably leads to the conclusion regarding the advisability of suspending the industry for the summer months. The maximum period of the ban is four months: June, July, August and September; the minimum, two months - July and August. It is possible that the most rational period will turn out to be three months: from the 15th of June to September 15.

I am aware of the fact that the proposed periods of the ban exclude the most productive period. However, putting into effect such a ban is compensated for by the transfer of the focus of the industry to the more profitable spring months. Of course this requires the reorganization of the industry. Nevertheless, I am firmly convinced in the necessity of such a reorganization for it will result in a rational industry based on biological premises, i.e. in the final analysis, to a more economical utilization of *222
the natural resources of the basin.

The harbour porpoise industry at the present time has a seasonal character. It is successfully caught in March and April during the return of the population from the Black Sea into the Sea of Azov (see Ch. II). During the same period the bottlenose is caught most successfully. It can only be recommended that the catching of these dolphin be conducted in the fall as well; in October-November when they aggregate in the area before the Strait for the Anchovy leaving the Sea of Azov.

Let us dwell on the utilization of the catches. It was clear from the preceding section how completely the caught animals were utilized during the initial organization of the industry. Unfortunately, this situation is not observed either during the period of its heyday or at the present time. Presently, only the blubber and the skins of the animals are utilized. The remainder is regarded as waste products of the industry. Is it possible to reconcile oneself to such a situation? In my opinion it is impossible, although unfortunately it seems to be common to all of the hunting industries with the exception of only the whaling industry.

It is completely unacceptable that the oil from the jaws is not utilized, the high quality and the successful application of which was already described by Arnold (1910) and a number of authors after him. According to our data and those of Okuneva (1934), on the average of 350 g of jaw oil can be obtained from a single common dolphin. In the bottlenose, this amount can be as high as 600 g. If these figures are carried over to the total number of animals caught, an extremely impressive amount of the most valuable raw material is going unused.

Attempts at preparing food products from dolphin meat, regarding which Mal'm (1932), Kravchenko (1932) and others had written about, were not crowned with success because of the extremely low taste quality of the products. But does this mean that technology has done everything possible for utilizing the meat? It seems to me that this indicates just the opposite, and the problem of the processing and utilization of the dolphin meat should again be posed before the technologists.

Such organs as the liver and brain of the dolphin, which do not undergo any special processing and are simply prepared by any housewife, are products of a very high taste quality which not only the dolphin fishermen know, but the entire surrounding population of the region of the industry as well. Nevertheless, they are not used.

The fins of the dolphin were effectively utilized by the adhesive industry and the skeleton went into the production of feed meal and fertilizers. *223 Why is this raw material not being used today? Has the need for the products from it fallen off? Certainly not. All of this only indicates that while there was a definite step forward taken in the technology of the industry during the period of its development, then in the area of the technology of processing the products of the industry, we not only have not progressed, but on the contrary, we have gone backwards which is completely intolerable.

Let us dwell on the blood of the dolphin. Its quantity flowing freely from the animal when it is killed is estimated by Okuneva (1934) as 4% of the weight of the animal. This large amount of blood in its total volume is never utilized. Meanwhile, it is well-known (I. V. Govorkov) that in the Far East during the dressing of the beluga, dark and light albumens having great demand in the various branches of industry, are prepared from the blood. Moreover, a high quality fodder meal is manufactured from the blood of the beluga. "Containing a considerable percentage of nitrogenous substances," writes Govorkov, "the blood meal is an extremely valuable fodder material and soil fertilizer.

If the serum, rich in protein substances is not separated out of the fresh blood and it is dried together with the coagulants, than an even more valuable fodder meal in terms of the nutrition obtained, having application even in medicine in the treatment of anemia" (I.V. Govorkov, 1934, p. 116).

Okuneva (1934), engaged in the blood chemistry of the Black Sea dolphin, notes that it "contains and extremely large percentage of solids[1] considerably in excess of that in other mammals, and as a result could give a greater yield of albumen.

Blood from a live dolphin was obtained in the following manner. It was dispatched with a knife stab to the heart after which the blood flowed in a stream from the wound; a bowl was held up to the wound. The collected blood was slowly agitated for 30 minutes to prevent coagulation. After agitation, the blood was filtered through gauze into a glass and was preserved." The experiments on the preserving of blood of the Black Sea dolphins conducted in 1931 gave positive results.

According to Okuneva's data (1934), studies by the laboratory of the Rostov Albumen Plant showed that dolphin blood contains 23.10% solids[1]; the albumen obtained contained 12.10% moisture; the solubility (on a dry substance) reaches 92.56%; solubility of the protein substances (on a dry substance) is 85.44%. The conclusion is given that it is suitable for manufacturing albumen.

In the beginning of the 1930's, a co-worker at the Rostov Albumen *224
Plant. A. Ya. Shirman, proposed a new method for preserving blood suitable in conditions of commercial operations. It consists of mixing 100 parts of defibrinated blood with 12 parts of 20% copper sulfate solution for 2-3 minutes. The mixture is then poured into conical coarse calico sacks, hung

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[1] Trans. note: I could not find a suitable translation of *plotnyi ostatok* which I have translated as "solids" since it does not seem as though the author was speaking of the sedimentation rate as the serum albumens and the protein substances remain in the plasma and only the erythrocytes, eosinophils, platelets, etc. precipitate out in this process.

out in the open air to drain off the fluid and is kept that way for about 2 days. The coagulated contents of the sacks are then stacked in a thin layer to dry naturally.

Experiments on the preserving of blood using Shirman's method in laboratory conditions and on a semi-factory scale gave positive results. Considering its relative cheapness and the simplicity of the procedures, this method in Okuneva's opinion (1934, pp. 111-112) can be used for preserving dolphin blood.

"In spite of the extremely valuable properties of dolphin blood," concludes Okuneva, "it goes to waste" (p. 112).

This was written 20 years ago. From that time on, in spite of the nearness of the albumen plant to the location of the industry, not one attempt was made at the commercial use of the blood of the Black Sea dolphin. Not being a technologist, I, naturally, cannot pretend to resolve the problems raised here, not even to completely enumerate them. Thus, for example, the possibility of utilizing the endocrine glands of the dolphins for the preparation of various medicinal compounds is quite probable.

It is obvious of course that in the technology of the processing of the products of the animal raw material, advancements have been made and new methods have been developed in comparison with which the information imparted by Govorkov (1934) and Okuneva (1934) are already obsolete. The knowledge of these methods, for understandable reasons, is inaccessible to me. My task was only to direct the attention of the economic organizations, under whose management the Black Sea dolphin industry falls, to the completely intolerable situation with the utilization of the products of this industry, by which, in my opinion, the space accorded to this problem is justified in this book.

I will try to formulate as breifly as possible the basic conditions directed at the rationalization of the industry.

1. At the present time, it is necessary to intensify the common dolphin industry within, naturally, intelligent limits.

2. The Azov-Black Sea dolphin industry must be broken up territorially. The harbour porpoise and the bottlenose industry can be based on shore; concerning the common dolphin industry, in long-term planning should *225 have a floating base and should basically be taken out into the open sea.

3. It is advisable to change the periods of the industry. The focus of the industry should be moved to the more profitable months, namely to March, April and May. It is advisable to suspend the industry completely from June 15 to September 15.

4. It is absolutely necessary to sharply improve the processing of the raw material and change over to a maximum utilization of the entire carcass of the animals.

The realization of these conditions, it goes without saying, will require expenditures, but we have to carry them through if we want to have a rationally organized industry based on biological premises.

"One of the slogans of the Soviet fisheries science of the present day is to progress from a fishing industry to a commercial fishing economy, not only to take its products from the sea, but to become intelligent managers on the seas..." (L. A. Zenkevich, 1951, p. 41). These words should be applied in full to the Black Sea dolphin industry, which is entirely a creation of the Soviet hunting industry.

GENERAL CONCLUSIONS

1. The mammalian fauna of the Black Sea and the Sea of Azov basin consists of four forms: one species of seal and three forms of dolphin, among which only the common dolphin alone can be considered as a Black Sea subspecies. The formation of a species and a subspecies within the other Azov-Black Sea dolphins (the harbour porpoise and the bottle-nose dolphin) should be considered incorrect for an analysis of the features advanced as diagnostic, indicated that they all come down to age, sex and individual variability, and as a result, cannot serve as a basis for the description of taxonomic categories.

2. There exists a basis for assuming that the history of the formation of the cetacean fauna of the basin followed a course different from the one presented by O. Abel and other researchers. Morphological, paleontological and helminthological data offer no grounds for considering the Azov dolphin as an autochthonous form in the basin. These data permit one to speak only of the aboriginal nature of the common dolphin while the other two species penetrated into the basin only after the formation of its connection with the Mediterranean Sea.

3. The Azov-Black Sea basin dolphins are intrinsically different from one another ecologically. The common dolphin is a typically pelagic and the most numerous form, inhabiting the entire water area of the Black Sea. The bottle-nose dolphin is a typically benthonic and scarce form, inhabiting only certain portions of the littoral zone of the Black Sea. The harbour porpoise is a benthonic form, but only in shallow water conditions; in conditions of the deep water basin, it changes to pelagic food but nevertheless keeps to the littoral zone. This dolphin populates basically the southern portion of the Sea of Azov and the Kerch Strait. It

spends the winter in the Black Sea. According to abundance, it is inferior to the common dolphin but superior to the bottlenose.

In this manner, every species occupies its own specific ecological niche in the basin.

4. The morphological and physiological characteristics of each one of them are in complete correspondence with the ecological characteristics. Each form is adapted to the conditions of its existence in the water body.

5. The eco-morphological and physiological characterists of the common dolphin point to its adaptability only to life in the superficial layers of the water. The uniqueness of the Black Sea consists in the fact that all life in the water body is concentrated in its superficial layers. Thus, just the common dolphin turned out to be the most adapted to these unique conditions of the Black Sea.

6. The absence of data which determine the natural mortality coefficient deprives us of the possibilty of approaching the calculation of their stocks from the point of view of the theory of population dynamics of animals.

Empirical methods for calculating the stocks of cetaceans are not developed and to consider the practicability of developing such methods at the present level of our knowledge is premature.

The development of a method for estimating the state of the stocks turned out to be practicable, which in practice is no less important. This method registers the changes in the age structure of the population occurring under the impact of the indusrty, and as a result, is perfectly suitable and can be recommended as an easily realizable check on the state of the dolphin stocks in the sea.

7. The main mortality factor of the common dolphin is helminthiasis,

caused by a pulmonary nematode. This disease increased sharply in the post-war period after an interruption in the industry. As a result, an intelligent intensification of the industry is necessary at the present time, which, nevertheless should be accompanied by an obligatory check on the state of the stocks of the animals in the sea.

8. The different distribution of the animals in the basin logically compels one to consider a different dispersion of the industry of the various species of dolphin advisable as well. The harbour porpoise industry should be based on the shore just as the entire industry is based at the present time. It is advisable to move the common dolphin industry into the open sea which has a floating base for the catching and processing of the catches.

9. Data on the biology of reproduction and fatness of the animals point to the necessity of a re-examination of the periods of the industry. It is advisable to suspend completely the industry during the summer period (the 15th of June to September 15), corresponding with the peak of reproduction of the dolphin and minimum fatness of the animals. Moreover, it should be organized in such a manner that the main volume of catches would fall in the winter months most profitable from that point of view, and es- *228
pecially the spring months (March, April and May), when the fatness of the dolphins reaches its maximum.

10. The present-day state of the processing of the catches requires reorganization with consideration of a maximum utilization of the animals which should become the urgent task of the engineering technologists.

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APPENDICES

APPENDICES

Appendix 1

Приложение 1

Cranial proportions of the bottle-nose dolphin (in % to overall length of cranium)

Пропорции черепа афалины (в % от общей длины черепа)

a) № пп.	(b) Наименование промеров	(c) Взрослые самцы (n=7)			(d) Взрослые самки (n=14)			(e) Неполовозрелые самцы (n=20)			(f) Неполовозрелые самки (n=14)		
		g минимум	h максимум	i среднее	g минимум	h максимум	i среднее	g минимум	h максимум	i среднее	g минимум	h максимум	i среднее
1	Общая длина черепа (в мм)	450	501	478	440	491	458	334	471	422	390	468	438
2	Основная длина черепа	96,6	98,4	97,4	97,2	98,1	98,0	96,3	98,5	98,2	97,4	98,2	97,8
3	Длина рострума	52,5	56,0	54,5	54,3	59,9	55,9	49,4	56,8	54,3	53,3	57,3	55,5
4	Длина альвеолярного ряда верхней челюсти	43,3	46,9	45,3	44,6	47,2	46,4	42,8	47,7	45,2	45,0	47,7	46,2
5	Наибольшая ширина черепа	51,1	55,5	52,9	48,9	52,8	50,8	47,1	52,8	50,6	48,9	53,1	50,9
6	Межглазничная ширина	45,4	49,1	47,1	41,0	46,3	44,7	42,3	47,7	45,2	42,8	47,1	44.7
7	Наибольшая ширина мозговой коробки	38,7	43,3	40,7	38,7	44,5	41,9	40,3	50,9	44,5	39,4	46,1	43.3
8	Наибольшая высота черепа	41,1	45,1	42,2	38,7	42,7	40,6	38,9	44,5	41,7	36,6	42,6	40.9
9	Ширина рострума у основания	26,2	28,2	27,3	24,8	26,9	25,9	24,2	27,4	25,5	24.9	27,0	25.7
10	Ширина рострума у последнего зуба	18,6	22,0	20,3	17,3	19,7	18,5	16,6	19,5	18,1	16,9	19,7	17,5
11	Высота рострума у последнего зуба	8,2	9,4	8,6	6,8	8,5	7,5	7,0	9,0	8,1	7,0	8,6	7,7
12	Ширина рострума в средней части	15,3	17,5	16,1	13,6	15,2	14,6	14,2	16,5	15,1	13,6	15,6	14.5
13	Ширина межчелюстных костей в средней части рострума	7,7	10,0	9,0	6,9	9,2	7,8	7,0	8,5	7,8	7,3	8,6	7,9
14	Длина межчелюстных костей	75,7	81,1	77,6	75,4	80,6	78,5	73,3	80,3	77,9	75,9	80,8	78,7
15	Длина основной кости	16,8	19,6	17,7	17,2	19,2	18,5	18,3	21,5	19,2	16,9	20,1	18,5
16	Длина лицевого отдела	64,2	68,8	65,9	64,2	68,0	66,2	59,9	65,8	64,9	63,8	67,2	66,0
17	Длина мозгового отдела	31,2	35,8	34,2	32,0	35,8	33,8	33,6	38,1	35,2	32,1	36,2	34,0
18	Высота затылочной области	35,2	39,8	37,4	35,3	39,7	37,4	37,8	40,9	39,4	36,8	38,8	37,5
19	Кондилярная ширина	19,5	21,8	20,4	18,7	22,2	20,4	18,6	20,8	19,6	18,7	22,2	20,2
20	Кондилярная высота	12,5	13,6	13,0	11,4	13,6	12,5	11,6	13,3	12,6	11,2	13,9	12,4
21	Ширина развилки межчелюстных костей	18,7	20,9	20,0	18,4	20,4	19,3	18,0	20,7	19,8	18,6	21,2	19,7
22	Поперечный диаметр дыхала	10,6	11,9	11,2	10,2	12,0	11,2	9,7	12,4	11,2	9,9	12,1	11,0
23	Расстояние между передним краем вырезки дыхала и линией максилярных вырезок	10,1	12,7	11,4	9,6	12,0	10,6	8,5	12,6	10,3	9,5	11,7	10,5
24	Расстояние от нижнего края затылочного отверстия до крыловидных костей	29,9	34,2	32,9	31,8	34,5	32,9	31,4	34,6	33,2	31,5	34,5	33,0

Appendix 1 (cont'd.)
Приложение 1 (продолжение)

№ пп.	Наименование промеров	Взрослые самцы ($n=7$)			Взрослые самки ($n=14$)			Неполовозрелые самцы ($n=20$)			Неполовозрелые самки ($n=14$)		
		минимум	максимум	среднее	минимум	максимум	среднее	минимум	максимум	среднее	минимум	максимум	среднее
25	Расстояние от нижнего края затылочного отверстия до заднего края альвеолярного ряда	49,7	52,9	51,8	51,4	54,1	52,6	49,5	57,8	53,1	51,0	54,8	52,3
26	Максимальная ширина черепа в передней части лба . . .	44,3	47,8	46,0	41,2	45,4	43,6	40,1	44,9	43,2	42,0	45,5	43,1
27	Расстояние от затылочного гребня до переднего конца рострума	85,1	88,5	87,5	83,3	91,0	86,5	83,2	87,8	85,6	84,7	89,4	86,5
28	Расстояние от верхнего промежутка носовых костей до переднего конца рострума .	78,5	81,3	79,4	78,6	82,0	80,2	77,5	81.3	78,5	78,4	82,7	80,3
29	Расстояние от переднего края височной впадины до переднего края лобных костей .	23,2	25,6	24,7	22,6	25,3	24,0	22,0	26,7	24,3	23,0	26,1	24,1
30	Ширина птеригоидного отверстия	15,9	17,7	16,9	14,7	16,4	15,4	14,1	18.0	15,1	14,4	16,4	15,6
31	Длина птеригоидного отверстия	13,4	16,8	15,3	13,5	15,7	14,8	12,8	16,2	14,5	13,4	16,2	14,9
32	Наибольшая длина височно-теменной впадины	22,6	23,9	23,6	21,4	24,8	23,0	21,0	23.9	22,7	22.1	24,9	23,3

№ пп.	Наименование промеров	Взрослые самцы ($n=7$)			Взрослые самки ($n=14$)			Неполовозрелые самцы ($n=20$)			Неполовозрелые самки ($n=14$)		
		минимум	максимум	среднее	минимум	макмум	среднее	минимум	максимум	среднее	минимум	максимум	среднее
33	Наибольшая высота височно-теменной впадины	14,4	15,7	15,2	13,4	16,6	14,9	13,7	16,8	15,0	12,7	17,0	14,7
34	Длина затылочного гребня по прямой	38,9	46,7	41,8	40,7	45,8	42,9	38,7	47,5	44,3	41,8	46,5	44,0
35	Длина затылочного гребня—лентой	49,8	58,9	52,1	49,9	59,6	54,8	51,1	60,9	57,5	52,9	59,0	56,5
36	Косая от нижнего края затылочного отверстия до заднего края височной дуги . .	34,0	35,6	34,5	33,0	35,3	34,3	32,7	36,6	34,5	33,4	35,4	34,6
37	Косая от середины крыловидных костей до переднего края височной дуги	25,5	27,1	26,2	23,7	30,0	25,0	23,1	26,7	24,7	24,0	26,1	25,1
38	Длина зуба в средней части верхней челюсти	12,0	16,0	13,7	5,0	12,0	10,8	9,0	12,5	11,0	10,2	13,5	11,4
39	Ширина зуба, там же	7,0	7,0	7,0	5,3	7,4	6,2	5,0	7,5	6,0	5,0	7,0	6,1
40	Частота зубов на протяжении 2,5 см	2,0	3,0	2,5	2,0	3,0	2,9	3,0	4,0	3,0	2,5	3,5	3,0
41	Количество зубов в каждой челюсти с обеих сторон — нижняя (lower)	38	42	40	34	42	38,3	36	43	39,4	37	43	39,7
	верхняя (upper)	38	45	42	40	45	42,4	38	47	42,1	39	47	43,0
42	Длина нижней челюсти . . .	83,3	85,6	84,1	81,7	84,5	83,3	81,2	85,9	83,6	81,8	85,9	83,5

Appendix 1 (cont'd.)

№ пп.	Наименование промеров	Взрослые самцы (*n*=7)			Взрослые самки (*n*=14)			Неполовозрелые самцы (*n*=20)			Неполовозрелые самки (*n*=14)		
		минимум	максимум	среднее	минимум	максимум	среднее	минимум	максимум	среднее	минимум	максимум	среднее
43	Длина альвеолярного ряда нижней челюсти: левая left	43,3	46,1	44,3	42,3	46,8	44,1	40,7	47,4	44,2	42,1	46,1	44,4
	правая right	42,9	46,1	44,2	42,3	46,6	44,1	40,1	46,6	44,3	42,3	46,6	44,4
44	Ширина основания нижней челюсти	19,0	19,6	19,3	17,5	19,3	18,4	17,2	19,2	18,4	17,2	19,7	18,4
45	Расстояние от вырезки у сочленовного мыщелка нижней челюсти до конца	78,4	80,5	79,3	78,3	81,6	79,9	76,5	82,2	79,8	78,7	82,3	80,0
46	Расстояние от заднего края сочленовного мыщелка до заднего края альвеолярного ряда нижней челюсти . .	39,9	40,5	40,1	38,0	41,4	39,9	37,5	42,5	39,5	38,7	41,0	39,7
47	Расстояние от заднего края сочленовного мыщелка до заднего края вырезки на внутренней стороне нижней челюсти	28,4	29,1	28,8	27,8	31,7	29,6	27,2	32,3	29,3	28,6	33,4	30,3
48	Наименьшая высота нижней челюсти	5,8	6,2	6,0	4,3	5,8	5,1	3,8	5,2	4,6	4,1	5,5	4,7
49	Высота нижней челюсти позади задних зубов	8,4	9,0	8,6	7,8	9,0	8,4	7,1	8,9	7,9	7,4	9,2	8,2
50	Длина симфизиса	10,6	12,3	11,4	10,5	12,3	11,4	8,6	13,2	10,4	9,6	13,2	11,4

Key to Appendix 1

a) Proportion number b) Name of measurement c) Adult males (n=7)

d) Adult females (n=14) e) Sexually immature males (n=20)

f) Sexually immature females (n=14) g) minimum h) maximum i) mean

1) Total length of cranium (in mm) 2) Basic length of cranium

3) Length of rostrum 4) Length of alveolar row of the maxilla

5) Greatest breadth of cranium 6) Interorbital breadth

7) Greatest breadth of braincase 8) Greatest height of cranium

9) Width of rostrum at its base 10) Width of rostrum at the last tooth

11) Height of rostrum at the last tooth

12) Width of rostrum at midlength 13) Width of premaxillaries at rostral midlength 14) Length of premaxillaries 15) Length of basilar process

16) Length of facial section 17) Length of cerebral section

18) Height of occipital region 19) Condylar width 20) Condylar height

21) Width of premaxillary bifurcation 22) Lateral diameter of blowhole

23) Distance between the anterior margin of the notch of the blowhole and the line of the maxillary notches

24) Distance from the anterior margin of the foramen magnum to the pterygoids

25) Distance from the inferior margin of the foramen magnum to the posterior margin of the alveolar row

26) Maximum breadth of cranium in the anterior portion of the frons

27) Distance from the occipital crest to the anterior tip of the rostrum

28) Distance from the superior interstice of the nasal bones to the anterior tip of the rostrum

29) Distance from the anterior margin of the temporal fossa to anterior margin of the frontals

30) Width of pterygoid foramen 31) Length of pterygoid foramen

32) Greatest length of the temporo-parietal fossa

33) Greatest height of the temporo-parietal fossa

34) Length of the occipital crest along a straight line

35) Length of the occipital crest - with a tape

36) A diagonal from the anterior margin of the foramen magnum to the posterior margin of the zygomatic arch of the temporal

37) Diagonal from the center of the pterygoids to the anterior margin of the temporal arch

38) Length of tooth at midlength of maxilla

39) Width of tooth in the same region

40) Frequency of teeth in a 2.5 cm length

41) Number of teeth in each jaw on both sides - lower - upper

42) Length of mandible

43) Length of alveolar row of the mandible - left - right

44) Width of base of mandible

45) Distance from the notch at the mandibular condyle of the mandible to the end

46) Distance from the posterior edge of the mandibular condyle to the posterior margin of the alveolar row of the mandible

47) Distance from the posterior edge of the mandibular condyle to the posterior margin of the notch on the interior side of the mandible

48) The smallest height of the mandible

49) Height of mandible behind the last back teeth

50) Length of symphysis

LEGEND TO APPENDICES 2, 3, 4, 5.

Hence forth, in the headings of the Tables oc cranial measurements of dolphins, the following legend is adopted:

KZMAN - Collection of the Zoological Museum of the USSR Academy of Sciences

KZMMU - Collection of the Zoological Museum of Moscow State University

KVNIRO - Collection of the All-Union Scientific-Research Institute of Marine Fisheries and Oceanography

The numbers of the measurements correspond to those in Appendix 1 where the designations are given. Moreover, in Column 1 of Appendices 2, 3, 4, and 5, the following abbreviations are adopted:

1/1 - lower left	u/1 - upper left	1 - left
1/r - lower right	u/r - upper right	r - right

Appendix 2 Pt. 1

Cranial measurements of D. delphis ponticus. Приложение 2

Промеры черепов Delphinus delphis ponticus[1]

№ промеров	1 № [illegible] КЗММУ Самец [illegible] см Ялта, 1948 г.	2 № [illegible] КЗММУ Самец 191 см Ялта, 1948 г.	3 № 56803 КЗММУ Самец 114 см Ялта, 1948 г.	4 № 56802 КЗММУ Самец 122 см Ялта, 1948 г.	5 № 56801 КЗММУ Самец 121 см Ялта, 1948 г.	6 № 6578 КЗМАН Сухум, 1879 г.	7 № 11441 КЗМАН Новороссийск, 1908 г.	8 № 6508 КЗМАН Черное море
1	420	397	299	301	300	417	413	395
2	413	391	295	297	294	411	407	390
3	258	241	166	169	166	252	256	240
4	216	196	137	143	135	204	206	195
5	178	174	128	130	—	173	173	170
6	159	153	116	113	113	153	151	152
7	144	135	117	126	121	147	146	137
8	153	146	109	112	111	150	—	146
9	83	80	62,4	59	60	84	83	81
10	60	57	45	45	45	62	50	55
11	33	33	25	26	24	35	33	30
12	51	48	34	37,5	38	50	43	46
13	19	17,3	13	15	15	24	20	20
14	352	329	232	236	235	348	346	325
15	64	67	66	58	61	73	67	64
16	307	288	198	204	200	304	301	283
17	113	109	101	97	100	113	112	112
18	131	125	98	95	98,5	126	122	126
19	85	82	65	62	71	82	81	76
20	50	51	37	36	41	50	48	51
21	75	68	55	56	51,4	71	70	66
22	47	43	33	33	33	45	41	42
23	49	47	32	35	34	52	45	43
24	120	118	97	—	—	121	—	116
25	196	194	155	154	159	201	202	203

Appendix 2 Pt. 1 (cont'd.)

Продолжение

№ промеров	№ 50805 КЗММУ Самец 196 см Ялта, 1948 г.	№ 50804 КЗММУ Самец 191 см Ялта, 1948 г.	№ 50803 КЗММУ Самец 114 см Ялта, 1948 г.	№ 50802 КЗММУ Самец 122 см Ялта, 1948 г.	№ 50801 КЗММУ Самец 121 см Ялта, 1948 г.	№ 6878 КЗМАН Сухум. 1879 г.	№ 11441 КЗМАН Новороссийск, 1908 г.	№ 6868 КЗМАН Черное море
26	160	154	114	110	114	154	153	151
27	373	359	266	278	269	372	367	351
28	353	332	239	243	243	351	350	326
29	92	90	69	72	72	97	88	86
30	54	52	42	42	42	51	50	46
31	56	51	36	—	—	50	—	50
32	71	60	50	56	53	67	69	72
33	47	38	33	34	35	47	45	49
34	151	133	112	126	120	150	146	143
35	200	185	150	175	160	200	190	185
36	121	118,5	91,3	89	91	119	116	116
37	88	88	68	—	—	87	—	87
38	6,7	6,7	5,6	4,4	4,2	—	—	8
.9	3	3	2	2	2	—	—	3
40	5	5	8	8	8	5	5	5
l/l п/л	44	41	41	45	40	42	4	44
l/r п/п	45	43	42	43	39	42	45	?
u/l 41 в/л	40	37	40	43	40	41	42	43
u/r в/п	41	38	42	42	39	41	41	42
42	352	330	240	246	—	357	350	339
l 43л	212	194	141	141	—	203	202	200
l 43л	212	194	141	141	—	203	202	199
44	65	59,4	41	—	45	66	—	—
45	344	318	232	237	—	345	335	327
46	143	139	107	105	—	157	150	141
47	107	105	77	78	—	113	109	113
48	15	15	11	13	12	15	14	13
49	31,4	31,3	21	23	21	32	32	32
50	42,6	42	27	30	—	41	—	—

From the Collection of Moscow State University Zool. Musem:

1) #50805, Male, 196 cm, Yalta 1948 2) #50804, M., 191 cm, Yalta, 1948

3) #50803, M., 114 cm, Yalta, 1948 4) #50802, M., 122 cm, Yalta, 1948

5) #50801, M., 121 cm. Yalta, 1948.

From the Collection of the USSR Academy of Sciences Zoological Musem:

6) #6878, Suhkumi, 1879 7) #11441, Novorossiisk, 1908

8) #6868, Black Sea.

Appendix 2 Part 2: Collection of the All-Union Sc.-Res. Instit. of Marine Fish. and Oceanogr. Zool. Mus.

1)#9, M., 179 cm, Yalta, 1933 2) #42, M., 185 cm, Novoross., 1933
3) #52, M., 181 cm, Novoross., 1933 4) #66, M., 165 cm, Batumi, 1934
5) #62, M., 195 cm, Novoross., 1934 6) #56, M., 186 cm, Novoross., 1934
7) #32, M., 121 cm, Yalta, 1934 8) #55, M., 183 cm, Novoross., 1934

Appendix 2 Part 2

Продолжение

№ промера	1 № 9 КВНИРО Самец 179 см Ялта, 1933 г.	2 № 42 КВНИРО Самец 185 см Новор., 1933 г.	3 № 52 КВНИРО Самец 181 см Новор., 1933 г.	4 № 66 КВНИРО Самец 165 см Батуми, 1934 г.	5 № 62 КВНИРО Самец 195 см Новор., 1934 г.	6 № 56 КВНИРО Самец 186 см Новор., 1934 г.	7 № 32 КВНИРО Самец 121 см Ялта, 1934 г.	8 № 55 КВНИРО Самец 183 см Новор., 1934 г.
1	395	402	380	382	413	392	327	392
2	390	396	375	375	407	387	323	387
3	237	240	218	225	250	237	192	236
4	194	203	182	188	209	192	155	196
5	173	171	172	173	176	169	141	173
6	152	149	152	156	154	147	125	153
7	139	136	130	144	141	142	127	132
8	144	144	141	141	149	142	147	139
9	84	84	81	85	84	82	69	85
10	53	60	55	55	61	57	47	59
11	31	32	30	32	35	31	26	34
12	44	48	46	44	48	47	38	45
13	19	21	20	21	21	20	16	21
14	329	334	318	317	343	333	276	324
15	70	74	62	70	73	68	63	79
16	285	289	272	272	300	287	232	285
17	110	113	108	110	113	105	95	107
18	127	129	123	121	130	125	100	121
19	79	83	79	80	86	83	71	85
20	49	47	50	48	48	47	39	50
21	68	68	67	66	68	62	63	66
22	41	46	42	47	43	41	35	41
23	48	49	54	47	50	50	40	49
24	122	120	—	—	122	115	101	—
25	202	193	188	188	195	192	168	190
26	152	150	153	158	156	149	124	156
27	352	354	339	340	367	353	294	347
28	332	345	320	321	346	336	273	331

Appendix 2 Part 2 (cont'd.)

Продолжение

№ промеров	№ 9 КВНИРО Самец 179 см Ялта, 1933 г.	№ 42 КВНИРО Самец 185 см Новор., 1933 г.	№ 52 КВНИРО Самец 181 см Новор., 1933 г.	№ 66 КВНИРО Самец 165 см Батуми, 1934 г.	№ 62 КВНИРО Самец 185 см Новор., 1934 г.	№ 56 КВНИРО Самец 186 см Новор., 1934 г.	№ 32 КВНИРО Самец 121 см Ялта, 1934 г.	№ 55 КВНИРО Самец 183 см Новор., 1934 г.
29	87	92	93	86	88	88	73	87
30	54	50	51	50	57	50	43	54
31	53	46	—	—	50	49	39	—
32	63	67	68	67	67	65	57	65
33	47	43	47	42	48	48	35	44
34	143	140	133	149	148	140	125	141
35	190	180	175	195	195	185	160	185
36	116	117	114	117	120	116	97	111
37	90	89	—	—	89	86	69	—
38	7	6	5	—	-	—	6	—
39	3	3	3	—			3	-
40	5	6	6	6	5	5	7	5
1/1 41н/л	41	41	48	48	47	45	43	?
1/r н/п	41	39	45	46	48	45	46	?
u/1 в/л	39	39	42	43	?	?	40	43
u/r в/п	38	39	—	44	?	?	41	?
42	334	336	324	320	334	334	277	338
1 43л	194	196	187	187	190	196	160	197
r п	194	196	185	186	208	196	162	199
44	63	64	62	59	63	64	50	64
45	323	327	315	308	323	320	270	327
46	142	142	142	134	137	142	120	144
47	109	107	102	105	100	107	93	114
48	15	15	14	13	15	17	12	15
49	31	31	33	32	32	30	25	32
50	41	43	35	35	—	—	37	—

Appendix 2 Part 3: From the Collection of the All-Union Sc.- Res. Instit. of Marine Fish. and Oceanogr. Zool. Museum.

1) #19, M., 177 cm, Yalta, 1934 2) #29, M., 155 cm, Yalta, 1934

3) #13, M., 188 cm, Yalta, 1933 4) #7, M., 156 cm, Yalta, 1933

5) #63, M., 174 cm, Novoross., 1934 6) #51, M., 181 cm, Novoross., 1933

7) #43, M., 144 cm, Novoross., 1933 8) #53, M., 166 cm, Novoross., 1933.

Продолжение

Appendix 2 Part 3

№ промеров	1 № 19 КВНИРО Самец 177 см Ялта, 1934 г.	2 № 29 КВНИРО Самец 155 см Ялта, 1934 г.	3 № 13 КВНИРО Самец 188 см Ялта, 1933 г.	4 № 7 КВНИРО Самец 156 см Ялта, 1933 г.	5 № 63 КВНИРО Самец 174 см Новорос., 1934 г.	6 № 51 КВНИРО Самец 181 см Новорос., 1933 г.	7 № 43 КВНИРО Самец 144 см Новорос., 1933 г.	8 № 53 КВНИРО Самец 166 см Новорос., 1933 г.
1	400	365	408	364	398	406	371	375
2	395	360	402	359	392	400	367	369
3	236	217	249	216	237	246	222	225
4	192	180	202	176	186	210	182	179
5	173	—	176	165	180	175	162	164
6	149	145	153	146	162	149	140	144
7	148	137	144	135	144	143	138	139
8	143	133	146	133	146	148	134	138
9	80	75	82	76	84	84	76	—
10	56	53	55	59	58	54	53	54
11	33	30	31	30	31	30	30	30
12	45	45	49	46	51	44	44	44
13	22	18	19	21	21	19	20	19
14	320	302	341	303	330	339	307	309
15	66	65	72	64	70	67	70	63
16	284	259	296	263	284	296	264	269
17	116	106	112	101	114	110	107	106
18	126	113	125	115	129	127	119	119
19	82	79	84	73	86	86	76	76
20	52	48	51	45	51	55	45	47
21	67	66	67	70	72	67	67	63
22	41	40	41	40	41	44	41	40
23	48	42	47	47	47	50	42	44
24	122	—	—	109	116	118	—	112
25	204	176	197	182	207	188	181	186
26	148	141	152	148	160	151	140	147
27	356	327	365	328	351	363	330	334
28	333	306	345	305	334	344	311	313
29	92	81	88	81	92	86	82	83
30	49	48	54	50	54	—	50	49
31	55	—	—	46	47	52	—	50
32	67	11	66	59	65	63	64	63
33	43	11	46	40	47	49	48	45
34	147	135	148	138	145	143	132	139
35	190	170	190	170	190	190	165	180
36	117	—	120	110	123	115	111	110
37	84	—	—	79	91	87	—	82

Appendix 2 Part 3 (cont'd.). Продолжение

№ промеров	№ 19 КВНИРО Самец 177 см Ялта, 1934 г.	№ 29 КВНИРО Самец 155 см Ялта, 1934 г.	№ 13 КВНИРО Самец 188 см Ялта, 1933 г.	№ 7 КВНИРО Самец 156 см Ялта, 1933 г.	№ 63 КВНИРО Самец 174 см Новорос., 1934 г.	№ 51 КВНИРО Самец 181 см Новорос., 1933 г.	№ 43 КВНИРО Самец 144 см Новорос., 1933 г.	№ 53 КВНИРО Самец 166 см Новорос., 1933 г.
38	7	6	7	6	—	7		6
39	3	3	3	3	--	3		3
40	6	6	6	6	5	5	7	6
l/l 41 н/л	?	40	45	44	48	42	46	41
l/r н/п	?	40	43	44	47	41	44	41
u/l в/л	45	36	?	?	?	40	?	39
u/r в/п	44	37	?	?	44	40	?	39
42	—	305	343	311	347	347	312	314
l 43л	—	179	206	177	206	195	176	185
r п	—	179	203	176	200	195	179	185
44	—	—	60	57	63	61	—	59
45	—	294	334	300	334	335	303	301
46	—	121	141	136	143	153	134	131
47	—	99	104	99	104	101	103	103
48	—	13	16	13	15	13	13	15
49	—	30	32	28	33	30	31	31
50	—	39	37	31	—	47	39	46

Appendix 2 Part 4: From the Collection of the All-Union Sc.-Res. Instit. of Marine Fish. and Oceanogr. Zool. Museum

1) #58, M., 170 cm, Novoross., 1934 2) #10, M., 189 cm, Yalta, 1933
3) #1, M., 171 cm, Batumi, 1934 4) #48, M., 164 cm, Novoross., 1933
5) #6, M., 176 cm, Novoross., 1933 6) #41, M., 176 cm, Novoross., 1933
7) #54, M., 175 cm, Novoross., 1933 8) #60, M., 175 cm, Novoross., 1934.

Appendix 2 Pt. 4 Продолжение

№ промеров	1 № 58 КВНИРО Самец 170 см Новорос., 1934 г.	2 № 10 КВНИРО Самец 189 см Ялта, 1933 г.	3 № 1 КВНИРО Самец 171 см Батуми, 1934 г.	4 № 48 КВНИРО Самец 164 см Новорос., 1933 г.	5 № 6 КВНИРО Самец 176 см Новорос., 1933 г.	6 № 41 КВНИРО Самец 176 см Новорос., 1933 г.	7 № 54 КВНИРО Самец 175 см Новорос., 1933 г.	8 № 60 КВНИРО Самец 175 см Новорос., 1934 г.
1	377	401	381	364	392	411	397	402
2	372	395	375	358	387	405	391	397
3	220	242	233	214	240	257	244	247
4	170	195	181	176	200	216	194	197
5	176	174	173	163	178	181	175	173
6	153	151	146	145	160	159	153	146
7	141	149	150	131	145	146	137	142
8	144	151	144	133	148	142	144	145
9	86	86	83	82	89	85	83	78

Продолжение

Appendix 2 Part 4 (cont'd.)

№ промеров	№ 58 КВНИРО Самец 170 см Новорос., 1934 г.	№ 10 КВНИРО Самец 189 см Ялта, 1933 г.	№ 1 КВНИРО Самец 171 см Батуми, 1934 г.	№ 48 КВНИРО Самец 164 см Новорос., 1933 г.	№ 6 КВНИРО Самец 176 см Новорос., 1933 г.	№ 41 КВНИРО Самец 176 см Новорос., 1933 г.	№ 54 КВНИРО Самец 175 см Новорос., 1933 г.	№ 60 КВНИРО Самец 175 см Новорос., 1924 г.
10	57	56	53	56	62	58	51	52
11	32	31	29	31	34	31	30	32
12	47	45	44	46	52	48	44	43
13	20	21	19	21	24	22	20	22
14	313	330	318	297	327	350	333	337
15	64	67	69	70	67	66	69	68
16	267	288	276	254	280	305	292	296
17	110	113	105	110	112	106	105	106
18	127	127	123	113	126	123	123	128
19	80	84	80	78	81	84	79	83
20	51	52	46	49	50	54	49	49
21	69	72	69	66	70	71	69	68
22	42	43	41	42	41	42	42	43
23	47	46	43	40	40	48	48	49
24	114	—	112	113	115	119	113	114
25	190	200	194	180	186	188	199	198
26	154	152	149	146	160	160	152	146
27	339	354	344	324	354	371	359	362
28	312	332	321	297	334	357	335	344
29	97	82	79	82	88	84	84	88
30	54	52	56	50	53	53	49	49
31	51		45	44	50	52	47	46
32	66	69	62	61	64	69	63	64
33	45	47	47	37	55	49	50	50
34	151	150	144	133	142	147	144	142
35	200	200	180	175	180	185	185	190
36	114	120	117	112	117	118	114	115
37	84	—	86	83	88	92	88	87
38	—	7	7	7	7	7	7	—
39	—	3	3	3	3	3	3	—
40	6	6	6	6	5	5	5,5	6
l/l н/л	?	46	45	41	41	41	44	43
l/r 41 н/п	?	47	45	39	42	39	43	43
u/l в/л	?	44	41	39	42	42	43	?
u/r в/п	?	44	?	41	?	42	43	?
42	322	336	320	313	335	350	347	340
l 43 л	183	195	189	182	200	210	209	198
r п	183	198	190	182	201	209	209	199
44	62	63	—	56	67	—	62	61
45	312	324	340	298	324	339	335	326
46	138	142	133	138	137	143	139	142
47	104	111	104	98	106	117	114	104
48	15	15	14	14	15	14	13	15
49	31	32	32	30	34	32	34	31
50	—	42	43	31	43	46	47	40

Appendix 2 Part 5: From the Collection of the All-Union Sc.-Res. Instit. of Marine Fish. and Oceanogr. Zool. Museum.

1) #72, M., 183 cm, Batumi 2) #33, F., 136 cm, Yalta, 1934

3) #8, F., 180 cm, Yalta, 1933 4) #4, F., 170 cm, Yalta, 1933

5) #37, F., 160 cm, Novoross., 1933 6) #47, F., 165 cm, Novoross., 1933

7) #2, F., 170 cm, Yalta, 1933 8) #70, F., 176 cm., Batumi

Appendix 2. Pt. 5

Продолжение

№ промеров	1 № 72 КВНИРО Самец 183 см Батуми	2 № 33 КВНИРО Самка 136 см Ялта, 1934 г.	3 № 8 КВНИРО Самка 180 см Ялта, 1933 г.	4 № 4 КВНИРО Самка 170 см Ялта, 1933 г.	5 № 37 КВНИРО Самка 160 см Новорос., 1933 г.	6 № 47 КВНИРО Самка 165 см Новорос., 1933 г.	7 № 2 КВНИРО Самка 170 см Ялта, 1933 г.	8 № 70 КВНИРО Самка 176 см Батуми
1	385	352	385	373	380	385	401	358
2	380	346	380	369	374	380	396	353
3	231	205	229	222	232	234	245	213
4	191	167	186	183	195	199	190	177
5	166	155	166	167	163	166	171	—
6	145	134	148	144	144	139	150	142
7	138	131	140	139	137	140	136	125
8	139	122	139	139	134	137	142	130
9	78	77	78	81	77	78	84	—
10	60	49	52	54	53	55	51	49
11	31	26	30	30	27	30	31	30
12	49	39	44	45	43	47	46	40
13	23	17	19	19	18	21	19	20
14	315	285	318	308	313	317	336	299
15	69	69	69	72	66	72	60	63
16	276	251	272	266	270	275	295	254
17	109	101	113	107	110	110	106	104
18	122	109	121	121	116	117	124	109
19	81	72	80	80	74	80	80	74
20	50	45	51	49	47	46	52	43
21	65	64	68	65	64	64	64	—
22	42	40	42	40	41	41	39	45
23	45	46	43	44	38	41	50	41
24	—	109	120	116	—	117	—	—
25	184	181	189	188	176	178	200	175
26	150	134	150	147	144	143	153	—
27	343	310	340	334	346	345	355	319
28	322	290	320	313	317	326	337	301
29	84	75	88	81	80	80	84	—
30	49	46	51	50	47	50	48	47
31	—	42	53	47	—	46	—	—
32	64	57	64	64	60	62	68	59
33	47	46	44	45	41	49	48	43
34	138	126	140	137	138	138	143	133
35	180	160	180	180	185	175	180	175
36	113	106	116	116	110	112	117	106
37	—	77	82	82	—	85	—	—

38	—	6	—	6	6	6	6	—
39	—	2,5	—	3	2,5	3	3	—
40	6	6	6	6	6	6	5,5	5
l/l 41 н/л	45	41	42	43	44	43	40	?
l/r н/п	44	41	43	43	43	43	40	?
u/l в/л	45	40	41	44	44	40	41	?
u/r в/п	46	40	41	?	44	43	41	?
42	326	293	321	308	317	318	341	310
l 43 л	190	171	183	179	184	191	200	180
?r п	189	171	183	179	186	193	200	178
44	60	—	59	59	—	59	66	58
45	315	285	308	296	306	306	330	302
46	137	120	139	132	134	128	144	133
47	103	99	103	97	108	106	115	108
48	16	13	13	14	13	14	14	12
49	33	28	30	29	30	33	32	30
50	37	36	36	39	45	44	46	—

Appendix 2 Part 6: From the Collection of the All-Union Sc. -Res. Instit. of Marine Fish. and Oceanogr. Zool. Museum.

1) #28, F., 123 cm, Yalta, 1934 2) #36, F., 167 cm, Novoross., 1933
3) #14, F., 183 cm, Yalta, 1933 4) #17, F., 158 cm, Yalta, 1934
5) #38, F., 157 cm, Novoross., 1933 6) #39, F., 164 cm, Novoross., 1933
7) #40, F., 164 cm, Novoross., 1933 8) #21, F., Yalta, 1934.

Продолжение

Appendix 2 Part 6

№ промеров	1 № 28 КВНИРО Самка 123 см Ялта, 1934 г.	2 № 36 КВНИРО Самка 167 см Новорос., 1933 г.	3 № 14 КВНИРО Самка 183 см Ялта, 1933 г.	4 № 17 КВНИРО Самка 158 см Ялта, 1934 г.	5 № 38 КВНИРО Самка 157 см Новорос., 1933 г.	6 № 39 КВНИРО Самка 164 см Новорос., 1933 г.	7 № 40 КВНИРО Самка 164 см Новорос., 1933 г.	8 № 21 КВНИРО Самка Ялта, 1934 г.
1	351	387	407	404	368	383	380	401
2	346	380	400	398	363	378	375	395
3	206	234	246	245	218	233	228	252
4	175	199	207	—	185	200	195	203
5	150	177	165	170	158	167	161	171
6	133	154	148	148	137	152	137	147
7	131	142	132	145	130	138	133	137
8	126	145	139	137	131	138	132	143
9	73	84	75	81	76	84	78	81
10	48	57	50	—	54	57	52	52
11	25	29	29	30	27	30	29	31
12	39	45	43	47	43	43	44	44
13	17	20	20	20	20	19	20	19
14	285	325	337	337	305	317	311	336
15	62	66	64	60	69	64	61	67
16	248	279	295	294	263	275	273	293
17	103	108	112	110	105	108	107	108
18	109	124	125	120	115	120	117	124
19	72	85	82	74	73	77	76	79

20	40	49	52	47	47	48	47	50
21	63	69	71	67	64	67	65	58
22	40	42	44	43	41	41	42	42
23	42	45	49	49	45	42	45	41
24	107	110	119	—	110	112	110	—
25	172	177	190	193	177	177	178	195
26	133	155	147	148	140	152	137	148
27	309	349	360	361	327	348	335	358
28	287	331	344	339	312	328	318	337
29	78	87	90	80	80	84	80	82
30	41	51	53	52	48	51	52	53
31	47	47	54	—	43	50	49	—
32	55	64	58	64	57	68	63	62
33	38	43	41	50	42	51	42	42
34	128	148	136	144	131	139	130	144
35	155	190	175	185	175	175	170	190
36	103	112	112	120	107	111	108	114
37	79	87	84	—	77	84	82	—
38	5	7	6	7	6	7	6	7
39	2	3	3	3	3	3	3	3
40	6	5	5	5	6	6	6	5
l/l " "	42	42	47	45	41	44	?	42
l/r 41 " "	41	42	46	44	41	45	?	43
u/l " "	37	45	42	?	41	44	40	39
u/r " "	?	44	45	46	41	44	40	42
42	292	332	343	342	309	325	—	340
l 43 "	171	194	202	201	181	191	—	206
r "	171	195	204	201	182	191	—	208
44	—	60	60	60	56	61	—	60
45	283	319	335	331	296	315	—	331
46	122	137	141	142	128	133	—	135
47	95	108	110	101	98	111	—	106
48	13	13	14	13	14	14	—	14
49	28	32	33	29	30	32	—	33
50	42	48	39	48	46	43	—	50

Appendix 3: From the Collection of the Al-Union Sc.-Res. Institute of Marine Fish. and Oceanogr. Zool. Museum and Moscow State U Museum

1) #5, F., Yalta, 1933 2) #12, F., 159 cm, Yalta, 1933

3) #67, F., 171 cm, Batumi 4) #74, F., 158 cm, Batumi

5) #6869, Atlantic Ocean 6) #6876, Rio De Janeiro, 1849

7) #6872, Atlantic Ocean, 1880.

Appendix 3

Приложение 3

Cranial measurements of Delphinus delphis.

Промеры черепов Delphinus delphis

№ промеров	1 № 5 КВНИРО Самка Ялта, 1933 г.	2 № 12 КВНИРО Самка 159 см Ялта, 1933 г.	3 № 67 КВНИРО Самка 171 см Батуми	4 № 74 КВНИРО Самка 158 см Батуми	MSU Museum 5 № 6869 КЗМАН Атлантич. океан	MSU Museum 6 № 6876 КЗМАН Рио-Жанейро, 1849 г.	MSU Museum 7 № 6872 КЗМАН Атлантич. океан, 1880 г.
1	409	371	380	365	408	435	458
2	402	366	374	360	402	429	449
3	243	226	228	218	251	268	290
4	203	189	—	181	200	227	245
5	176	165	170	160	177	179	192
6	153	143	150	141	162	155	170
7	139	142	137	129	141	143	153
8	147	137	144	133	152	146	160
9	84	72	75	79	91	84	99
10	59	54	—	54	66	59	72
11	32	30	29	31	36	37	41
12	49	40	44	43	53	49	59
13	24	18	20	19	26	22	25
14	344	313	312	303	341	365	384
15	65	65	62	64	75	66	71
16	298	270	274	259	297	322	334
17	144	104	106	106	144	113	124
18	122	122	125	113	134	130	140
19	82	74	74	71	86	87	92
20	48	50	52	45	49	50	53
21	71	63	—	72	75	69	76
22	44	41	41	42	42	42	44
23	55	44	46	41	46	54	44
24	—	—	—	—	122	123	126
25	199	176	182	181	198	202	202
26	155	141	148	141	163	—	173
27	368	331	340	321	362	386	407
28	344	316	322	304	342	373	389
29	93	80	82	79	88	94	92
30	56	49	50	49	55	54	59
31	—	—	—	—	50	55	55
32	65	60	64	58	63	65	71
33	47	46	45	43	43	54	56
34	140	143	139	132	158	150	170
35	180	180	180	170	205	190	215
36	116	111	113	108	149	117	124
37	—	—	—	—	90	93	95
38	7	7	—	—	—	8	—
39	3	3		—		3	—
40	5	6	5	5	6	5	5
l/l н/л	41	45	47	?	44	50	50
l/r н/п	41	46	48	?	44	51	48
u/l в/л	40	42	?	?	44	47	49
u/r в/п	40	45	?	?	44	47	51

Продолжение

Appendix 3 (cont'd.)

№ промеров	№ 5 КВНИРО Самка Ялта, 1933 г.	№ 12 КВНИРО Самка 159 см Ялта, 1933 г.	№ 67 КВНИРО Самка 171 см Батуми	№ 74 КВНИРО Самка 158 см Батуми	№ 6869 КЗМАН Атлантич. океан	№ 6876 КЗМАН Рио-Жанейро, 1849 г.	№ 6872 КЗМАН Атлантич. океан, 1880 г.
42	347	310	343	319	349	370	401
1 43 I	205	186	209	180	208	225	247
r II	205	186	209	182	206	227	243
44	64	58	60	59	67	62	65
45	335	304	332	307	340	358	382
46	143	126	137	138	143	148	156
47	111	100	105	104	107	109	115
48	18	13	13	13	15	14	18
49	37	30	32	28	32	32	38
50	41	42	42	—	48	47	61

Appendix 4 Part 1: From the Collection of Moscow State Univeristy Zool. Mus.

1) #52551, M., Anapa, 1949,132 cm 2) #52557, M., 128 cm, Anapa, 1949

3) #52552, M., 127 cm, Anapa, 1949 4) #52558, M., 124 cm, Anapa, 1949

5) #52556, M., 142 cm, Anapa, 1949 6) #52553, F., 127 cm, Anapa, 1949

7) #52554, F., 129 cm, Anapa, 1949 8) #52559, M., 120 cm, Anapa, 1949

Appendix 4 Pt. 1
Приложение 4

Cranial measurements of Phocaema phocaena

Промеры черепов *Phocaena phocaena*

№ промеров	1 № 52551 КЗММУ Самец 132 см Анапа, 1949 г.	2 № 52557 КЗММУ Самец 128 см Анапа, 1949 г.	3 № 52552 КЗММУ Самец 127 см Анапа, 1949 г.	4 № 52558 КЗММУ Самец 124 см Анапа, 1949 г.	5 № 52556 КЗММУ Самец 142 см Анапа, 1949 г.	6 № 52553 КЗММУ Самка 127 см Анапа, 1949 г.	7 № 52554 КЗММУ Самка 129 см Анапа, 1949 г.	8 № 52559 КЗММУ Самец 120 см Анапа, 1949 г.
1	239	236	223	232	229	233	243	229
2	235	231	218	227	224	227	237	224
3	104	107	96	104	100	102	108	105
4	90	96	82	87	83	87	93	88
5	134	142	132	131	130	131	132	127
6	112	119	111,4	107	108,5	110	110	106
7	114,4	116	114	115	115	113,5	114	106
8	118	120	113	113	111	109	118	108
9	66	69	66	64	60,6	66	70	62,5
10	56	60	53	52	50	52	54	49
11	17,3	20	17,2	19	19	19	18	17
12	40	42	37	36	38	38	39	37
13	19,4	22	17,6	18	17,4	19	19	19
14	147	150	133	152	143	146	153	147

	15	60,6	56	58	56	57	56	61	57,5
	16	134	142	121	133	129	131	143	129
	17	105	94	102	99	100	102	100	100
	18	108	107	104	104	102	97	106	100
	19	51	51	51	50	54	51	55	53
	20	34	34	33	34	32	33	34	33
	21	34	36	31	36	29	34	31	32
	22	24	24	22	25	21	24	24	25
	23	30	35	25	29	29	29	35	24
	24	92	87	88	83	—	88	90	85
	25	149	145	140	139	144	141	150	140
	26	105	114	104	100	106	107	107	100
	27	197	200	183	198	190	192	200	191
	28	175	173	154,5	168	167	164	175	168
	29	62	64	61	61	61	61	62	61
	30	37	38	38	38	37	35	37	36
	31	32	30	31	28	—	32	30	27
	32	57	59	54	55	56	56	59	52
	33	34	36	35	33	34	32	36	34
	34	112	115	112	114	110	111	111	106
	35	155	155	150	150	145	150	—	145
	36	101	102	98	94	99	100	100	94
	37	67	69	67	67	—	66	67	63
	38	4	4,6	5	4,6	—	5	—	—
	39	1,4	2	2	2	—	2	—	—
	40	7	7	—	7	—	7	—	—
l/l	41 н/л	24	?	23	24	24	25	23	26
l/r	н/п	24	24	?	24	24	26	23	26
u/l	в/л	24	24	?	?	?	26	?	?
u/r	в/п	26	?	?	28	?	26	26	?
	42	181	—	172	178,4	172	175	—	178
l	43 л	83	—	83	88	80,5	86	89	86
r	п	85	87	—	88	83	86	89	86
	44	45	49,5	46	47	45	45	—	45
	45	170	—	163	170	162,3	168	170	170
	46	101	—	91	93	91	92	—	92
	47	80	—	72	69	70	69	—	70
	48	14	—	14	13	14	14	14	12
	49	22,5	25	25	23	23	24	24	22
	50	20	22	16	22	21	19	22	21

Appendix 4 Part 2: From the Moscow State University Zool. Museum Collection

1) #52555, M., 124 cm, Anapa, 1949 2) #52560, M., 122 cm, Anapa, 1949

3) #21156, M., 145 cm, Enikale, 1936 4) #23126, M., 1938,

5) #21159, M., 134 cm, Kerch, 1936 6) #21157, M., 136 cm, Kerch, 1936

7) #21164, M., 115 cm, Kerch, 1936 8) #21160, F., 157 cm, Enikale, 1936

Appendix 4 Pt. 2

Продолжение

№ промера	1 № 52555 КЗММУ Самец 124 см Анапа, 1949 г.	2 № 52560 КЗММУ Самец 122 см Анапа, 1949 г.	3 № 21156 КЗММУ Самец 145 см Еникале, 1936 г.	4 № 23126 КЗММУ Самец, 1938 г.	5 № 21159 КЗММУ Самец 134 см; Керчь, 1936 г.	6 № 21157 КЗММУ Самец 136 см Керчь, 1936 г.	7 № 21164 КЗММУ Самец 115 см Керчь, 1936 г.	8 № 21160 КЗММУ Самка 157 см Еникале, 1936 г.
1	231	228	252	252	255	246	208	271
2	225	223	246	246	247	238	203	265
3	103	101	110	115	113	107	86	121
4	86	85	92	97	94	96	74	102
5	130	127	—	145	147	147	123	158
6	104,4	108	119	118	120	119	101	131,5
7	110	110	—	124	124	—	110	131,5
8	108	—	117	121	122	124	104	126
9	64	64,4	66	75	71	74	58	81
10	48	51	58	62	57	59	47	64
11	17	18	19	20	17	19	17	20
12	35	37	43,5	47	45	46	36	49,4
13	17	19	20	21	19,4	22	17	22
14	149	—	—	—	—	—	—	—
15	56	62	70,5	65,3	65	65	55	65
16	131	129	146	145	148	139	114	160
17	100	99	106	107	107	107	94	111
18	96	—	107	106	109	112	93	108
19	50,5	54	54	59	62	57	46	58
20	33	34	34	37	35,5	37	29	38
21	30	34	35	35	36,4	34	30,5	41
22	24	20	29	28	28	27	20	29
23	28	28	36	30	35	32	28	39
24	88	87	—	98	93	92	83	97
25	146	143	157	157	157	153	130	168
26	96	101	114	117	118	110	93,5	129
27	188	—	209	213	226	205	178	231
28	166	—	185	184	192	178	148	201
29	61	60	65	63	65	67	52	70
30	35	36	—	44	—	43,4	37	45
31	33	27	—	33	30	27	28	33
32	56	55	—	61	—	—	59	68
33	31	35	—	42	35	34	31	40
34	108	—	112	118	121	124	106	124
35	145	—	150	155	155	160	140	160
36	97	95,5	—	107	110	108	95	118,5
37	65	64	—	74	73,4	71	63	77
38	5	5	5	5	—	5	—	—
39	2	1,6	2	2	—	2	—	—
40	—	8	7	6	—	7	—	—
l/l 41 н/л	21	?	21	25	?	22	23	?
l/r н/п	21	?	22	24	?	22	?	?
u/l в/л	?	?	26	25	?	24	?	?
u/r в/п	?	?	28	?	?	25	?	?
42	176	—	192	193	—	186	157	206

l 43л	77	—	91	95	92	88	78	103,4
r п	77	—	90	93	93	86	74	99
44	44	45	—	50	—	48	—	54
45	166	—	184	184	—	176	..	195
46	100	97	104	101	—	100	81	104
47	71	—	—	78,4	—	74,3	73	85
48	12	12,5	14	16	18	14,5	11	16
49	21	24	—	28	29	26	24	31
50	20	—	22	21	—	22	20	21,4

Appendix 4 Part 3: From the Collections of Moscow State U. Zool. Mus. (1-4, incl.) and USSR Academy of Sciences Zool. Mus. (5-8, incl.).

1) #21161, F., 165 cm, Kerch, 1936 2) #21162, F., 180 cm, Kerch, 1936
3) #21163, F., 116 cm, Kerch, 1936 4) #21158, F., 139 cm, Kerch, 1936
5) #15774, F., 121 cm, Crimea, 1928 6) #13869, F., Sevastopol, 1928
7) #11442 , Gulf of Finland, 1915 8) #21983, Grebnitskii

Продолжение

Appendix 4 Part 3

№ промеров	1 № 21161 КЗММУ Самка 165 см Керчь, 1936 г.	2 № 21162 КЗММУ Самка 180 см Керчь, 1936 г.	3 № 21163 КЗММУ Самка 116 см Керчь, 1936 г.	4 № 21158 КЗММУ Самка 139 см Керчь, 1936 г.	5 № 15774 КЗМАН Самка 121 см Крым, 1928 г.	6 № 13869 КЗМАН Самка, Севастополь, 1928 г.	7 № 11442 КЗМАН Финский залив, 1915 г.	8 № 21983 КЗМАН Гребницкий	9 № 6887 КЗМАН Атлантический океан
1	279	279	228	247	238	239	259	259	269
2	271	—	221	240	233	233	254	253	263
3	130	130	99	109	111	111	105	107	122
4	110	111	88	92	91	89	94	95	108
5	159	158	130	142	133	141	145	146	142
6	131	—	111	119	103	119	120	120	119
7	120	124	116	120	109	118	129	141	123
8	128	129	113	120	111	122	128	134	127
9	83	—	64	72	70	72	70	73	73
10	66	68	52	59	55	56	61	59	66
11	19	20	19	20	17	18	23	22	24
12	50	51	40	45	39	45	48	43	49
13	25	26	19	22	19	26	22	22	23
14	—	—	—	—	150	147	147	152	166
15	67	—	60	65	61	58	68	73	70
16	170	164	125	138	142	138	138	143	154
17	109	115	103	109	96	100	121	116	115
18	115	—	101	107	98	105	110	125	123
19	63	—	52	60	51	59	71	70	68
20	39	—	34	35	32	36	43	39	38
21	40	40	33	35	31	35	37	40	36
22	31	29	24	25	24	28	31	28	28
23	40	34	26	29	31	27	33	36	32
24	93	—	86	91	87	86	109	98	103
25	166	—	134	153	143	147	165	164	160
26	129	—	104	115	—	117	119	111	116
27	234	238	198	211	198	200	207	219	227
28	209	212	164	178	178	180	179	184	194

29	75	—	56	64	61	65	69	79	74
30	46	47	40	44	—	44	48	48	50
31	28	—	28	28	27	29	39	29	35
32	63	66	57	—	—	58	54	52	49
33	37	42	34	36	38	35	34	31	39
34	121	120	114	116	102	117	127	144	120
35	165	165	150	150	140	155	170	190	160
36	113	—	99	—	—	100	113	113	103
37	79	—	66	71	—	70	75	68	67
38	6	—	—	7	—	6	—	5	3
39	2	—	—	2	—	2	3	3	2,5
40	6	—	—	—	—	6	6	7	6
l/l н/л	21	25	24	24	?	23	?	26	24
l/r 41 н/п	23	25	?	24	?	22	?	26	24
u/l в/л	22	?	?	?	?	23	?	25	?
u/r в/п	23	25	?	?	?	23	?	25	26
42	211	215	168	188	185	185	—	198	206
l 43 л	99	104	86	91	99	92	?	91	102
r п	102	102	86	93	99	87	92	92	104
44	55	—	47	47	47	48	—	50	54
45	202	206	162	178	178	176	—	186	198
46	113	113	85	96	88	95	—	108	108
47	87	91	70	78	76	79	—	81	87
48	16	16	13	15	13	15	16	15	16
49	26	29	24	28	28	28	26	23	27
50	26	27	21	22	—	23	24	28	25

Appendix 5 Part 1: From the Collection of the Moscow State U. Zool. Museum

1) #50766, F., 207 cm, Yalta, 1948 2) #50760, M., 217 cm, Yalta, 1948
3) #50799, M., 190 cm, Yalta, 1948 4) #50751, M., 210 cm, Yalta, 1948
5) #50758, M., 194 cm, Yalta, 1948 6) #50769, M., 219 cm, Yalta, 1948
7) #50762, M., 193 cm, Yalta, 1948 8) #50757, M., 199 cm, Yalta, 1948.

Cranial measurements of Tursiops tursio

Appendix 5
Приложение 5
Pt. 1

Промеры черепов *Tursiops tursio*

№ промеров	1 № 50766 КЗММУ Самка 207 см Ялта, 1948 г.	2 № 50760 КЗММУ Самец 217 см Ялта, 1948 г.	3 № 50799 КЗММУ Самец 190 см Ялта, 1948 г.	4 № 50751 КЗММУ Самец 210 см Ялта, 1948 г.	5 № 50758 КЗММУ Самец 194 см Ялта, 1948 г.	6 № 50769 КЗММУ Самец 219 см Ялта, 1948 г.	7 № 50762 КЗММУ Самец 193 см Ялта, 1948 г.	8 № 50757 КЗММУ Самец 199 см Ялта, 1948 г.
1	427	436	428	471	450	460	421	437
2	418	423	412	459	440	449	412	426
3	242	246	233	266	252	260	238	245
4	203	199	190	221	209	215	194	208
5	219	229	215	222	217	230	208	220
6	190	208	192	201	198	206	181	199
7	192	190	195	195	184	201	193	199

№ промеров	№ 50756 КЗММУ Самка 207 см Ялта, 1948 г.	№ 50760 КЗММУ Самец 217 см Ялта, 1948 г.	№ 50749 КЗММУ Самец 190 см Ялта, 1948 г.	№ 50751 КЗММУ Самец 210 см Ялта, 1948 г.	№ 50758 КЗММУ Самец 194 см Ялта, 1948 г.	№ 50769 КЗММУ Самец 219 см Ялта, 1948 г.	№ 50762 КЗММУ Самец 193 см Ялта, 1948 г.	№ 50757 КЗММУ Самец 199 см Ялта, 1948 г.
8	179	190	185	191	175	191	172	177
9	111	112	113	117	112	118,4	115,5	106
10	78	82	75	79	80	86	70	78
11	34	38	35,5	36	34,2	36	32,5	30,5
12	63	72	63	68	66	72,7	61,2	66,6
13	35	36	36	37	33,5	36,7	32	37,3
14	344	342	329	361	363	360	331	343
15	72	85	81	87	90	89	86	81
16	287	283	273	310	299	302	278	286
17	140	153	155	161	151	158	143	151
18	162	172	175	178	173	180	169	173
19	85	91	89	96	89	94	86	81
20	55	58	56	56	52	56	51	51
21	83,4	93,2	85,2	84,6	89	86	82	84,5
22	44	53	53	54	52	51	49	53
23	45	37	40	44	47	42	40	41
24	135	150	145	149	—	150	135	139
25	226	228	224	233	231	234	221	220
26	185	191	187	191	191	200	169	177
27	384	376	358	394	380	392	361	366
28	353	354	338	374	356	374	342	348
29	103	101	94	117	109	108	104	107
30	70	64	63	68	68	73	60	62
31	65	67	65	68	—	63	54	59
32	105	101	98	101	101	103	90	100
33	62	73	64	71	65	74	57	62
34	189	195	190	191	174	195	185	198
35	245	255	240	250	230	255	250	260
36	150	151	147	154	148	153	139	148
37	109	116	105	109	—	117	102	109
38	11	11,2	10	12,4	11,1	11,7	12,7	12,5
39	6	6,4	6	7,5	6,3	7,4	6,5	6,8
40	3	3	3	3	3	3	3	3
41 l/l н/л	20	18	21	19	19	18	19	22
l/r н/п	21	20	21	17	20	18	18	21
u/l в/л	23	21	23	20	21	22	24	?
u/r в/п	22	22	23	23	21	21	23	25
42	359	375	349	389	373	385	359	366
l 43 л	189	186	188	207	191	202	189	189
r п	192	193	190	207	195	206	190	187
44	84	83	78	81	78	83	74	78
45	348	355	335	374	355	368	346	353
46	173	185	161	181	177	182	170	181
47	125	131	122	135	132	125	122	124
48	20	22,6	17	23	18,8	23,4	21	16,7
49	36,5	34	35	36	36	36,5	31,4	31,7
50	46	45,3	37	61	43	44,5	42,6	39

Appendix 5 Part 2: From the Collection of Moscow State U. Zool. Museum

1) #50781, M., 210 cm, Yalta, 1948 2) #50755, M., 190 cm, Yalta, 1948
3) #50791, M., 167 cm, Yalta, 1948 4) #50767, M., 197 cm, Yalta, 1948
5) #50756, M., 208 cm, Yalta, 1948 6) #50794, M., 192 cm, Yalta, 1948
7) #50774, M., 192 cm, Yalta, 1948 8) #50796, M., 197 cm, Yalta, 1948.

Appendix 5 Pt. 2 Продолжение

№ промеров	1 № 50781 КЗММУ Самец 210 см Ялта, 1948 г.	2 № 50755 КЗММУ Самец 190 см Ялта, 1948 г.	3 № 50791 КЗММУ Самец 167 см Ялта, 1948 г.	4 № 50767 КЗММУ Самец 197 см Ялта, 1948 г.	5 № 50756 КЗММУ Самец 208 см Ялта, 1948 г.	6 № 50794 КЗММУ Самец 192 см Ялта, 1948 г.	7 № 50774 КЗММУ Самец 192 см Ялта, 1948 г.	8 № 50796 КЗММУ Самец 197 см Ялта, 1948 г.
1	451	—	449	427	427	—	382	414
2	441	—	439	417	418	—	373	404
3	241	226	255	224	235	—	200	221
4	206	191	214	188	196	—	172	177
5	232	219	224	219	224	215	194	214
6	207	192	190	190	198	194	—	192
7	189	187	186	188	188	185	184	180
8	180	176	177	175	180	168	159	170
9	116	106	113,5	104,5	116	115	93,6	104,3
10	82,2	74,7	80	77,6	83,1	74	69,3	76
11	36,3	35	36	34	37	31,2	34,2	32
12	70	61,4	65	60,8	67,3	—	59,9	62
13	32	34	33	30	40	—	31	33,7
14	344	323	357	335	330	—	291	326
15	88,3	—	82,3	82,2	80,1	84,2	82,2	79,5
16	294	267	298	278	280	—	242	267
17	157	—	151	149	147	—	140	147
18	177,4	—	173	172	170	172	150	164
19	95,3	—	87,4	95,7	88	88	79,4	83,6
20	55	—	52,3	54,4	51,5	53,1	46,3	54
21	88,6	86,5	85	85,2	88,3	87,5	78	83,5
22	49,4	41,3	48,2	49,2	48,7	46,3	41,7	40,3
23	53	41	43	54	45	45	42	46
24	150,2	—	141,2	143,4	143,3	142,6	—	—
25	238	—	230	230	223	232	208	228
26	196	183	196	182	191	182	—	185
27	383	359	376	365	374	—	331	348
28	358	335	359	336	343	—	303	329
29	113	107,7	105	106,7	104,3	102,2	94	102
30	65	65	65,5	67	62	65,2	60,6	59,6
31	63,5	65	61,3	64	64	61,2	—	—
32	97,4	93,7	95,4	97,3	100,7	108	96	92
33	68,5	63,2	65,2	67	67	63,4	66,5	57,5
34	197	184	186	189	189	191	180	186
35	250	250	250	250	240	255	240	245
36	156,2	—	148	155	147	148,1	136,6	140
37	107	107	106	105	105,3	106,1	—	—
38	12	11,2	11,7	11,3	11,5	—	11,5	9,5
39	6	5,6	5,8	6,3	6,2	—	7	5,3

	40	3	3	3	3	3	—	3	3
l/l	41 н/л	21	20	20	21	20	21	19	20
l/r	н/п	19	20	20	20	19	21	19	19
u/l	в/л	23	21	21	22	21	?	20	20
u/r	в/п	22	21	21	22	20	?	18	20
	42	375	346	373	358	354	368	315	348
l	43 л	207	184	203	195	194	204	170	184
r	п	205	182	203	193	193	204	168	182
	44	84	79,7	79,2	78,7	81,2	78,4	70	76,3
	45	359	331	358	339	337	358	302	332
	46	170,6	165	170,6	163,6	162	165	149	167
	47	136,1	125	122	118,2	126	131,5	106	124
	48	19,1	17,5	20	18,7	19,8	20,8	19	18
	49	35,6	31,4	35	35,7	37,6	35	27	34
	50	45,4	37	48,8	48	39,5	50	49,2	42,5

Appendix 5 Part 3:From the Collection of the Moscow State U. Zool. Museum

1) #50773, M., 188 cm, Yalta, 1948. 2) #50752, M., 182 cm, Yalta, 1948
3) #50789, M., 195 cm, Yalta, 1948 4) #50754, M., 175 cm, Yalta, 1948
5) #50753, M., 155 cm, Yalta, 1948 6) #50784, M., 223 cm, Yalta, 1948
7) #50772, F., 200 cm, Yalta, 1948, 8) #50783, F., 232 cm, Yalta, 1948.

Appendix 5 Pt. 3

Продолжение

№ промеров	1 № 50773 КЗММУ Самец 188 см Ялта, 1948 г.	2 № 50752 КЗММУ Самец 182 см Ялта, 1948 г.	3 № 50789 КЗММУ Самец 195 см Ялта, 1948 г.	4 № 50754 КЗММУ Самец 175 см Ялта, 1948 г.	5 № 50753 КЗММУ Самец 155 см Ялта, 1948 г.	6 № 50784 КЗММУ Самец 223 см Ялта, 1948 г.	7 № 50772 КЗММУ Самка 200 см Ялта, 1948 г.	8 № 50783 КЗММУ Самка 232 см Ялта, 1948 г.
1	382	405	409	394	334	461	458	468
2	376	397	401	386	329	454	448	459
3	206	218	222	203	165	254	258	267
4	175	177	188	169	135,6	215	215	215
5	—	214	205	198	178	232	239	229
6	172	192	181	176	156	210	211	200
7	180	191	186	—	170	186	209	196
8	164	176	166	168	147	190	191	182
9	93,2	104	103	95,5	87,5	117,3	119	119
10	67	73	73	70	62	89	87	82
11	31,4	31,6	30,7	33	28,4	37	36	33
12	58,5	59,5	59	62,3	52	71,5	71,4	67
13	28	30,6	29	33,6	24,6	38	37,3	33
14	280	319	318	294	248	364	370	374
15	81,2	81,7	75	82	78,5	90	86,3	81,4
16	244	260	267	244	200	302	305	315
17	138	145	142	150	134	159	153	153
18	153	164	158	149	136	180	175	168
19	76	87,3	80	78,7	76	96,5	86	89
20	51	50,8	49	52	47,2	58	51,5	56
21	78,7	80,6	81	76	72	89,2	93	86,5
22	41,5	43	42,3	39	41	46	50	51

23	38	42	45	41	35	48	47	48
24	132	142,2	138,4	142,4	131	147,6	147,6	152
25	202	229	216	216	193	245	238	244
26	163,5	186	170	171,4	150	202	205	205
27	332	354	359	336	278	393	401	403
28	302,6	327	324	302	259	368	370	379
29	96	96,2	96	100	89,3	112,2	106	108
30	56,3	62	61	59,6	60	66,3	66	69
31	55	62,7	63	59,7	54	59,6	65,5	71
32	—	98	86	88	—	107	114	114,5
33	58,7	61	59	55	53	65	75	68
34	181,3	188	187	184	172	201	213	197
35	240	245	240	240	230	265	270	260
36	—	147	142	144	—	159	161	156
37	—	108	102	99	—	113,5	117,3	111
38	-	10,3	11	—	9	10,3	10,7	11,7
39	—	6,7	6,3	—	5	5,3	6,4	6
40	3	3	3	—	4	3	3	3
l/l п/л	22	20	18	?	19	20	22	22
l/r 41 н/п	21	19	19	?	18	20	21	22
u/l в/л	?	19	20	?	20	22	23	22
u/r в/п	?	20	18	?	19	22	21	25
42	324	344	343	320	274	393	383	391
l 43 л	181	176,3	175	170	136	215	205	201
r п	178	174	178	170	134	212	204	204
44	71,4	77,7	73,3	66,6	63	88,6	88,5	83,6
45	311	330	326	306	262	376	367	372
46	143,2	170	171	151	142	179	181	193
47	109	129	127	114,5	100	135	135	142
48	16,4	19	16	19	16,4	22	24,4	25
49	34	34	30	30	25	43,5	40	37
50	33,5	43,4	42	—	25	51,4	60,5	54

Appendix 5 Part 4: From the Collection of Moscow State U. Zool. Musem

1) #50765, F., 233 cm, Yalta, 1948 2) #50785, F., 234 cm, Yalta, 1948
3) #50800, F., 210 cm, Yalta, 1948 4) #50775, F., 216 cm, Yalta, 1948
5) #50786, F., 228 cm, Yalta, 1948 6) #50770, F., 236 cm, Yalta, 1948
7) #50754, F., 237 cm, Yalta, 1948 8) #50797, F., 241 cm, Yalta, 1948

Appendix 5 Pt. 4 Продолжение

№ промеров	1 № 50765 КЗММУ Самка 233 см Ялта, 1948 г.	2 № 50785 КЗММУ Самка 234 см Ялта, 1948 г.	3 № 50800 КЗММУ Самка 210 см Ялта, 1948 г.	4 № 50775 КЗММУ Самка 216 см Ялта, 1948 г,	5 № 50786 КЗММУ Самка 228 см Ялта, 1948 г.	6 № 50770 КЗММУ Самка 236 см Ялта, 1948 г.	7 № 50754 КЗММУ Самка 237 см Ялта, 1948 г.	8 № 50797 КЗММУ Самка 241 см Ялта, 1948 г.
1	468	447	451	454	463	462	459	458
2	459	437	442	445	452	449	448	447
3	262	243	257	259	260	261	254	256
4	220	205	215	211	211	218	212	214
5	238	232	224	227	230	236	230	240
6	213	206	196	199	190	209	202	209
7	197	190	195	179	179	200	193	195
8	190	182	184	180	187	185	184	190

	9	121	118	113,4	114	121	119	118,4	120
	10	92	83,6	79	82	80,4	80	84	86
	11	34,7	33,7	34	33	34	31,5	32	34,5
	12	70	66	63,4	64,5	64,6	63	70	66
	13	39,2	41	33,3	33	35	33	37,5	33
	14	377	347	357	354	362	368	358	359
	15	—	82,6	83,4	88,4	87,2	86,2	86,3	88
	16	307	287	300	305	305	314	303	302
	17	161	160	151	149	158	148	156	156
	18	186	174	168	167	172	163	172	172
	19	95	98	94	99	93,6	94	96,5	98
	20	61,6	60	57,4	63	55	53	61	62,5
	21	92	87	89	85	85	89	88	89
	22	56	47	45	45	47	51,6	51,4	52,5
	23	45	44	43	46	45	53	49	46
	24	154,3	151	142	146	150	—	146,4	152
	25	249	233	231	235	247	243	244	236
	26	204	190	187	193	200	204	199	203
	27	403	373	396	385	394	410	390	399
	28	374	354	362	358	371	379	364	368
	29	116,5	110	107,3	110	106	111,3	109	112
	30	76	67	68	68	72	70	71	71,7
	31	—	69,5	61,4	61	65	—	62,4	65,4
	32	107	99	100,4	101	106	102	98	110
	33	70	64	69,2	61,3	70	70,3	67	76
	34	201	193	196	192	188	195	200	202
	35	260	250	250	250	240	250	250	250
	36	165	157	152,5	157	155	154,5	160	160
	37	111,4	116	109	115	113	—	109	116
	38	5	9	12,5	11	11,3	11,2	12	11
	39	7,4	6,6	6	6	5,6	6,2	6	6
	40	2,5	3	3	3	3	3	3	3
l/l	41 п/л	?	18	20	21	19	19	20	19
l/r	п/п	?	19	20	20	19	19	19	19
u/l	в/л	22	22	21	24	22	20	21	22
u/r	в/п	22	22	22	23	22	20	20	21
	42	389	368	376	377	380	390	380	385
l	43 л	203	196	204	204	204	207	194	200
r	п	201	199	210	201	201	210	196	201
	44	89	83,5	77,6	84	81	81,6	84,5	88
	45	377	350	360	363	366	377	364	371
	46	191	174	175	177	176	187	188	186
	47	138,5	132,3	132	130	122,6	132	134,5	141
	48	27	24	23,5	18,5	21,5	22,6	24	25
	49	41	38,4	35	35,6	36	37	37,6	41
	50	53	52	56	56	56	51	51	52

Appendix 5 Part 5: From the Collection of the Moscow State U. Zool. Museum

1) #50782, F., 228 cm, Yalta, 1948 2) #50787, F., 226 cm, Yalta , 1948
3) #50759, F., 215 cm, Yalta, 1948 4) #50779, F., 214 cm, Yalta, 1948
5) #50776, F., 213 cm, Yalta, 1948 6) #50768, F., 236 cm, Yalta, 1948
7) #50790, F., 206 cm, Yalta, 1948 8) #50798, F., 237 cm, Yalta, 1948.

Appendix 5 Pt. 5

Продолжение

	1	2	3	4	5	6	7	8
№ промеров	№ 50782 КЗММУ Самка 228 см Ялта, 1948 г.	№ 50787 КЗММУ Самка 226 см Ялта, 1948 г.	№ 50759 КЗММУ Самка 215 см Ялта, 1948 г.	№ 50779 КЗММУ Самка 214 см Ялта, 1948 г.	№ 50776 КЗММУ Самка 213 см Ялта 1948 г.	№ 50768 КЗММУ Самка 236 см Ялта, 1948 г.	№ 50790 КЗММУ Самка 206 см Ялта, 1948 г.	№ 50798 КЗММУ Самка 237 см Ялта, 1948 г.
1	454	458	447	444	464	—	—	440
2	445	448	436	434	455	—	—	430
3	250	252	249	242	264	—	—	246
4	210	212	210	207	219	—	—	207
5	225	240	230	220	232	238	—	—
6	200	210	206	190	201	208	203	200
7	189	199	184	179	183	202	186	187
8	183	187	182	180	185	193	187	184
9	116	123	114	110,5	115	123	114	110
10	80	87	79,5	76	82	79	87	81
11	32	35,2	34	36	32	34	32	36
12	66,5	68	65	63	63	—	—	65
13	34,4	36,4	36	36,5	32	—	—	37,5
14	354	360	349	—	367	—	—	347
15	87	80	76	79	80	83	83	85
16	301	304	295	285	309	—	—	289
17	153	154	152	159	155	—	—	151
18	165	171	165	165	171	171	165	165
19	89	93,6	89,5	94	91	95	97	86
20	54,6	56,4	51	57	57	56,5	55	53
21	84	90	86	83,5	92	94	91	84,5
22	49	51	50	50	53	55	50	48
23	51	52	46	43	45	—	—	43
24	156,5	—	146,5	150	150	149	145	145
25	242	243	232	231	242	246	228	226
26	191	205	197	185,6	191	200	192	193
27	378	397	388	377	403	—	—	390
28	357	372	364	351	375	—	—	359
29	102,5	116	111	108	110	116	—	—
30	71	75	70	69,5	73,6	68	9	65
31	71	—	70	70	70	68	65,5	65
32	107	105,5	100	—	107	107	—	—
33	67	67	68	63	70	74	—	—
34	192	201	196	187	195	207	196	190
35	240	255	250	240	250	265	260	250
36	158	157	149,5	—	153	—	—	—
37	110	—	110	—	115	—	—	—
38	11,3	10,7	12	10,2	12	—	—	12
39	6,4	6	6,2	6	6,3	—	—	7
40	3	3	3	3	3	3	3	3
l/l н/л	19	19	20	20	19	?	20	20
l/r 41 н/п	19	19	19	19	19	?	19	?
u/l в/л	22	20	21	20	21	?	21	21
u/r в/п	21	21	22	21	22	22	21	20
42	371	387	377	367	389	392	374	370
l 43 л	197	209	206	187	204	208	205	206
r п	194	207	208	189	203	206	201	205
44	—	85	80,5	80,5	82	85	84	84
45	358	369	360	350	373	377	360	353
46	175	183	174	181	188	190	177	167
47	128,5	142	134	138	129	142	126	131
48	24	24	19,5	22	20	22	20	19
49	38,5	40	36	33,4	37	35	36	39
50	56	54,5	52,5	46,5	55	—	56,5	47

Appendix 5 Part 6: From the Collection of the Moscow State U. Zool. Museum

1) #50778, F., 184 cm, Yalta, 1948 2) #50771, F., 210 cm, Yalta, 1948

3) #50792, F., 181 cm, Yalta, 1948. 4) #50793, F., 211 cm, Yalta, 1948

5) #50780, F., 226 cm, 1948, Yalta 6) #50777, F., 196 cm, Ylata, 1948

7) #50795, F., 166 cm, Yalta, 1948 8) #50761, F., 244 cm, Yalta, 1948.

Appendix 5 Pt. 6

Продолжение

№ промеров	1 № 50778 КЗММУ Самка 184 см Ялта, 1948 г.	2 № 50771 КЗММУ Самка 210 см Ялта, 1948 г.	3 № 50792 КЗММУ Самка 181 см Ялта, 1948 г.	4 № 50793 КЗММУ Самка 211 см Ялта, 1948 г.	5 № 50780 КЗММУ Самка 226 см Ялта, 1948 г.	6 № 50777 КЗММУ Самка 196 см Ялта, 1948 г.	7 № 50795 КЗММУ Самка 166 см Ялта, 1948 г.	8 № 50761 КЗММУ Самка 244 см Ялта, 1948 г.
1	425	445	436	468	445	431	390	440
2	415	437	426	456	433	421	381	431
3	232	247	235	267	248	241	210	239
4	195	202	196	222	207	200	172	201
5	208	224	224	244	235	224	194	223
6	187	193	193	210	206	201	170	200
7	196	184	196	200	198	184	175	193
8	170	182	183	194	190	178	156	182
9	107	111	115	120	115	114	98	115
10	74	79	77	79	86	83	69	86
11	33,4	32	35	35	36	32	33,4	37,5
12	58	62	64	66	66	66	56	66
13	34	35	35	35,5	36	36	30	37
14	330	357	342	376	354	—	296	344
15	85,4	83	84,5	81	82,6	74	77	80,5
16	278	297	285	318	297	283	249	292
17	147	148	151	150	148	148	141	148
18	157	166	169	173	173	162	145	169
19	86	90	97	94	99	89	76	92
20	50	54	57	58	58	53	48	58
21	83	83	89	99	91	85	72,5	87
22	46	48	50	56	51	52	42	53
23	46	50	50	51	49	42	39	53
24	142,3	152	143	152	144	—	134,6	147,4
25	222	237	239	244	229	220	210	238
26	181,4	184	183	201	202	196	167	193
27	360	386	379	409	405	378	332	382
28	335	358	347	382	363	348	314	349
29	100	105,5	114	110	109	103	96	110
30	64	72	66	74	68	69	63	66,4
31	59	72	63	73	65	—	59,6	69
32	98	107	102	113	103	102	86,6	109
33	54	62	66	72	70	62,5	51	64
34	192	189	195	208	204	190	175	196
35	250	250	250	260	265	245	230	255
36	148	154	152	159	157	151	132	154

37	102	111	112	118	113	—	98	108
38	12	10,5	10,5	13,5	12	11,5	10	11
39	7	6	5	6,2	6	6	6	5,3
40	3	3	3	2,5	3	3	3,5	3
l/l 41 н/л	20	20	?	19	18	19	21	20
l/r н/п	19	19	?	19	19	18	20	19
u/l в/л	23	21	20	22	21	21	21	22
u/r в/п	23	20	19	23	21	21	?	20
42	351	373	—	402	374	359	319	364
l 43 л	187	200	—	211	197	186	168	187
r п	185	197	—	210	199	185	165	186
44	81	77,5	84	84	86	81	87	80,6
45	339	358	—	385	360	343	307	350
46	167	175	176	192	181	176	151	182
47	129,5	134	137	147	138	144	145	139,6
48	18	19,5	—	22,5	26	23,7	17	20,3
49	37,5	35	40	36	39	36	29	35
50	41	49	—	50,5	51	55	41	46

Appendix 5 Part 7: From the Collections of Moscow State U. (1-2, incl.), Acad. of Scien. Mus. (4-5, incl.), All-Union Sc.-Res. Inst.of Marine Fish. and Oceanogr. (5-8, incl.)

1) #50788, F., 168 cm, Yalta, 1948 2) #50763, F., 195 cm, Yalta, 1948
3) #22530, Adriatic Sea, 1868 4) #21982, Mediterranean Sea,
5) #9, F., 231 cm, Yalta, 1934 6) #13, F., 234 cm, 1934
7) #2(1), M., 250 cm, Yalta, 1934 8) #8(7), M., 310 cm, Yalta, 1934

Appendix 5 Pt. 7

Продолжение

№ промеров	1 № 50788 КЗММУ Самка 168 см Ялта, 1948 г.	2 № 50763 КЗММУ Самка 195 см Ялта, 1948 г.	3 № 22530 КЗМАН Адриатич. море, 1868 г.	4 № 21982 КЗМАН Средиземн. море	5 № 9 КВНИРО Самка 231 см Ялта, 1934 г.	6 № 13 КВНИРО Самка 234 см 1934 г.	7 № 2(1) КВНИРО Самец 250 см Ялта, 1934 г.	8 № 8(7) КВНИРО Самец 310 см Ялта, 1934 г.
1	—	418	486	449	491	—	471	492
2	—	410	474	440	478	—	458	479
3	—	230	283	233	268	—	264	274
4	—	192	234	194	219	—	221	230
5	196	222	237	—	244	—	249	260
6	175	197	215	203	224	206	222	231
7	179	189	194	204	191	181	196	193
8	161	178	—	186	190	185	200	202

9	93	113	130	119	129	118	128	133
10	66	82	96	88	92	85	95	102
11	32	35	41	42	37	32	42	45
12	—	65	77	72	73	—	76	76
13	—	36	37	40	38	—	45	39
14	—	328	400	342	370	—	382	374
15	82	79	88	92	91	90	79	86
16	—	275	333	281	323	—	324	327
17	—	143	153	168	168	—	147	165
18	154	160	—	170	177	163	166	181
19	80	78	100	99	92	82	95	102
20	46	51	61	60	56	57	59	65
21	72	85	91	93	95	84	88	102
22	47	46	51	58	56	53	50	54
23	—	45	50	48	55	—	60	53
24	133	142	149	—	—	—	141	158
25	240	222	240	245	258	236	234	247
26	166	190	240	—	220	202	217	227
27	—	361	429	389	422	—	417	420
28	—	335	403	348	389	—	383	392
29	96	103	112	—	113	112	114	114
30	62	67	76	80	73	75	75	84
31	55	65	63	—	—	—	63	72
32	87	101	111	—	106	—	111	111
33	53	71	72	—	66	62	71	76
34	182	192	217	202	200	190	198	191
35	240	240	265	265	245	240	240	245
36	140	148	160	—	165	—	160	170
37	96	109	115	—	—	—	120	126
38	—	11,6	—	—	—	—	12	—
39	—	6,2	—	—	—	—	7	—
40	—	3	2,5	2,5	2	3	3	2,5
l/l н/л	?	20	23	?	21	?	21	?
l/r 41 н/п	?	19	24	?	21	?	21	?
u/l в/л	?	21	24	?	21	?	21	22
u/r в/п	?	21	24	18	21	21	21	24

42	—	347	405	—	411	—	403	—
l 43 л	?	187	223	—	222	—	217	—
r п	?	191	228	—	223	—	218	—
44	67	80	92	—	86	—	91	—
45	302	331	393	—	385	—	379	—
46	153	165	185	—	192	—	188	—
47	—	123	132	—	145	—	137	—
48	17	21	25	—	24	—	29	—
49	33	36,3	41	—	41	—	40	—
50	—	—	—	—	—	—	58	—

Appendix 5 Part 8: From the Collection of the All-Union Sc.-Res. Instit. of Marine Fish. and Oceanogr. Zool. Museum.

1) #9(8), M., 256 cm, Yalta, 1934
2) #3, M., 271 cm, Yalta, 1934
3) #11(14), M., 256 cm, Yalta, 1934
4) #11, M., 277 cm, Gelendzh., 1934
5) #1, M., 183 cm, Yalta, 1934
6) #10, M., 180 cm, Yalta, 1934
7) #6(4), M., 304 cm, Yalta, 1934
8) #5, F., 214 cm, Yalta, 1934.

Appendix 5 Pt. 8

Продолжение

№ промеров	1 № 9(8) КВНИРО Самец 256 см Ялта, 1934 г.	2 № 3 КВНИРО Самец 271 см Ялта, 1934 г.	3 № 11(14) КВНИРО Самец 256 см Ялта, 1934 г.	4 № 11 КВНИРО Самец 277 см Геленндж., 1934 г.	5 № 1 КВНИРО Самец 183 см Ялта, 1934 г.	6 № 10 КВНИРО Самец 180 см Ялта, 1934 г.	7 № 6(4) КВНИРО Самец 304 см Ялта, 1934 г.	8 № 5 КВНИРО Самка 214 см Ялта, 1934 г.
1	450	478	464	501	—	402	491	435
2	440	463	448	493	—	391	480	425
3	238	251	251	277	—	208	269	232
4	195	212	211	229	—	176	220	196
5	250	246	246	256	191	217	264	220
6	221	217	218	229	170	199	238	195
7	195	195	199	194	173	185	190	188
8	203	198	197	207	164	179	204	182
9	127	125	127	137	92	109	138	113
10	99	89	90	97	62	77	108	76
11	39	38	39	41	30	36	46	34
12	76	73	73	79	57	59	86	59
13	45	37	42	43	29	33	49	33
14	346	362	354	398	—	315	383	335
15	88	82	84	85	77	84	87	82
16	289	310	298	334	—	257	324	383
17	161	168	166	?	—	145	167	152
18	179	174	175	196	138	159	182	164
19	89	93	96	112	77	85	107	82
20	58	60	61	78	48	58	65	57
21	94	89	97	102	70	84	96	90
22	52	52	55	55	41	48	56	47
23	51	59	47	57	—	49	55	51
24	154	—	154	170	129	—	167	—
25	238	253	240	268	202	215	258	230
26	215	213	211	222	162	190	234	187
27	388	407	400	428	—	349	422	370
28	354	375	365	407	—	316	393	341
29	115	120	117	119	91	99	125	100
30	79	77	78	84	61	62	87	68
31	68	—	70	84	54	—	82	—
32	111	114	111	116	82	96	115	96
33	70	69	73	76	49	64	72	65
34	210	199	191	202	181	186	205	182
35	265	250	235	255	245	240	250	230
36	168	170	160	171	133	147	169	151
37	121	—	122	129	94	—	133	—
38	—	13	—	16	9	—	—	12

	39	—	7	—	7	6	—	—	7
	40	2,5	3	2,5	2	4	3,5	2	3
l/l	41 н/л	19	?	?	20	20	21	?	?
l/r	н/п	?	?	?	18	21	21	?	?
u/l	в/л	21	21	20	21	?	?	21	21
u/r	в/п	21	21	20	22	?	?	21	21
	42	375	—	—	418	302	338	—	—
l	43 л	195	—	—	215	161	181	—	—
r	п	195	—	—	215	?	185	—	—
	44	88	—	—	90	—	79	—	—
	45	353	—	—	396	291	325	—	—
	46	180	—	—	203	143	158	—	—
	47	128	—	—	155	111	130	—	—
	48	26	—	—	30	15	19	—	—
	49	40	—	—	42	29	33	—	—
	50	—	—	—	53	—	—	—	—