EWA RONIEWICZ and ELŻBIETA MORYCOWA

DEVELOPMENT AND VARIABILITY OF TERTIARY *FLABELLUM RARISEPTATUM* (SCLERACTINIA), KING GEORGE ISLAND, WEST ANTARCTICA

(Plates 19—24)

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The paper presents results of studies on *Flabellum rariseptatum* RONIEWICZ et MORYCOWA, 1985 from the Cape Melville and Destruction Bay Formations (Tertiary) of King George Island, Antarctica. The corals are mainly from thin bedded shales, siltstones and fine sandstone of the glacio-marine Cape Melville Formation, most probably of Lower Miocene age. All post-larval skeletal stages are represented beginning with basal plate with initial septal apparatus composed of 12 protosepta up to large individuals with complete six septal cycles and some septa of higher cycles (S7 and S8). The corals are characterized by variable shape from conical to flabellate, thin pedicel, and low septal density; at the adult stage they are unattached but stand vertically in soft sediment. Corallum morphology, shape of septa and feeble development of columella as well as an initial twelve-septal stage in ontogeny link this species to Recent *Flabellum thouarsii*-group of species known from the Antarctic and sub-Antarctic regions.

Key words: Scleractinia, *Flabellum* morphology, ontogeny, ecology, King George Island, Lower Miocene, Antarctica.

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ROZWÓJ I ZMIENNOŚĆ TRZECIORZĘDOWEGO *FLABELLUM RARISEPTATUM* (SCLERACTINIA) Z WYSPY KRÓLA JERZEGO, ANTARKTYKA ZACHODNIA

Streszczenie. — Korale *Flabellum rariseptatum* RONIEWICZ et MORYCOWA, 1985 pochodzą z trzeciorzędowych osadów z bogatą fauną, które zostały odkryte na Wyspie Króla Jerzego (Płd. Szetlandy) w Antarktyce Zachodniej, podczas V Polskiej Wyprawy Antarktycznej PAN w sezonie 1980/1981 (BIRKENMAJER 1982*a*, 1987, GAŹDZICKI i WRONA 1982). Osady koralonośne należą do wydzielonej przez BIRKENMAJERA (1982*b*, 1984) grupy Moby Dick, złożonej z trzech formacji: bazaltowej formacji Sherratt Bay, klastycznej formacji Destruction Bay powstałej z przetworzenia law bazaltowych, oraz przykrywającej je, lodowcowo-morskiej formacji Cape Melville. Wiek jednej z dajek andezytowych przecinających formację Cape Melville, zbadany metodą K-Ar, wynosi około 20 mln lat, co wskazuje, że formacja ta jest wieku wczesnomioceńskiego lub nawet starsza.

Omówione korale ukazują się w profilu po raz pierwszy w piaskowcach formacji Destruction Bay, lecz dopiero w łupkach i mułowcach z głazami eratycznymi formacji Cape Melville występują obficie (fig. 1). Osady tej ostatniej zawierają liczną i zróżnicowaną faunę bentosową oraz szczątki ryb i okrzemki. Oprócz licznych korali (wyłącznie *F. rariseptatum*) występują tu małże, a wśród nich semi-infaunalne formy w pozycji życiowej, ślimaki (KARCZEWSKI 1987, w tym tomie), aparaty szczękowe wieloszczetów (SZANIAWSKI i WRONA 1987, w tym tomie), rurki wieloszczetów, kraby — pancerze (FÖRSTER *et al.* 1985) i odlewy nor (FÖRSTER *et al.* 1987, w tym tomie), jeżowce (SZYMAŃSKA 1987, w tym tomie), otwornice (*fide* GAŹDZICKI i WRONA 1982). Obok nich na wtórnym złożu występują apcko-albskie belemnity (BIRKENMAJER *et al.* 1987, w tym tomie) oraz górnokredowe kokkolity (DUDZIAK 1984).

Flabellum rariseptatum należy do grupy, która obejmuje 3 dzisiejsze gatunki występujące na szelfie południowoamerykańskim, 2 okołoantarktyczne i 2 endemity nowozelandzkie, oraz oligoceński *Flabellum* sp. z Argentyny. Cechy wspólne grupy to nieornamentowana powierzchnia koralita, owalny kielich z tendencją do silnego spłaszczenia, stosunkowo cienki pedicel zachowany przez całe życie osobnika, co najmniej 5 cykli septów, tendencja do tworzenia wcięcia na dystalnym brzegu septów i dość słaby rozwój kolumelli. *Flabellum rariseptatum* ma w najwcześniejszym stadium postlarwalnym postać dwunastoseptową oraz stosunkowo rzadkie septa na brzegu dystalnym (10—12/10 mm i mniej) u dorosłego osobnika. Jest to gatunek o bardzo zmiennym kształcie (od wąskostożkowego do szeroko rozpostartego, wachlarzowatego) i dużych maksymalnych rozmiarach koralitów (pl. 19—24; figs. 3—10).

Spośród wszystkich gatunków należących do wymienionej grupy, *F. rariseptatum* ma najwięcej cech wspólnych z dzisiejszym głębokowodnym (647—2229 m) *F. areum* CAIRNS. Dorosła postać tego ostatniego przypomina formy stożkowatego morfotypu *F. rariseptatum*. Ze względu na charakter podobieństwa, gatunki te można uważać za bezpośrednio filogenetycznie związane. Kształtem i rozmiarami koralita *F. rariseptatum* przypomina eurybatyczny (46—2260 m) *F. impensum* SQUIRES. Ten ostatni odznacza się dużą między- i wewnątrzpopulacyjną zmiennością kształtu koralita, co jest uważane za odpowiedź na zróżnicowanie lokalnych warunków środowiska. Ze względu na analogiczny zakres zmienności kształtu, *F. rariseptatum* można uważać za gatunek tak plastyczny, jak *F. impensum*, a zatem z dużym prawdopodobieństwem — za gatunek występujący w dużym zakresie głębokości. W przypadku formacji Cape Melville, zarówno typ osadów, jak i różnorodność stowarzyszonej z koralami fauny wskazują na środowisko znajdujące się w obrębie zewnętrznego szelfu (BIRKENMAJER 1982b, 1984), a więc dochodzące najwyżej do paruset metrów głębokości.

Jego dorosłe osobniki były zakotwiczone w pozycji pionowej w miękkim osadzie. Młode żyły zapewne przyczepione do nietrwałych obiektów na dnie lub do skonsolidowanego na powierzchni osadu ilastego, rzadko do okruchów skalnych, itp. Osobniki przewrócone ginęły masowo przy wzburzeniu wody i osadu podczas częstych wstrząsów sejsmicznych, których wpływ na rozwój bentosu jest tu zakładany (FÖRSTER *et al.* 1987, w tym tomie). Duży procent osobników zbioru (60%) to formy młodociane na różnych stadiach rozwoju (fig. 10). Tak znaczna śmiertelność form niedojrzałych (w rachunku tym nie są uwzględnione oczywiście stadia przedszkieletowe, wśród których z reguły jest ona największa) musiała być równoważona u tego gatunku przez zdolność do obfitej produkcji larw.

INTRODUCTION

The corals of this study were collected from Tertiary rocks, most likely Lower Miocene, at the Melville Peninsula, King George Island, South Shetland Islands, West Antarctica (fig. 1). The strata were discovered during the 5th Polish Antarctic Expedition in the austral summer 1980—1981 (BIRKENMAJER 1982*a*, 1987 this volume; GAŹDZICKI and WRONA 1982). On the Melville Peninsula, the Moby Dick Group was differentiated and described by Birkenmajer (1982*b*, 1984). The group begins with basalt lavas of the Sherratt Bay Formation, overlain by sedimentary strata of the Destruction Bay and Cape Melville Formations. *Flabellum rariseptatum* mainly occurs in a glacio-marine sequence of the Cape Melville Formation, and is less common in the underlying Destruction Bay Formation. The whole sequence of the Moby Dick Group is cut by numerous andesite and basaltic dykes. One of the dykes cutting the Cape Melville Formation was recently dated at 20 ± 0.3 Ma by the K-Ar method indicating that the formation is of Lower Miocene age or older (BIRKENMAJER *et al.* 1985).

This study covers material from two collections: the first contained over 360 specimens, assembled by A. GAŹDZICKI and R. WRONA and housed at the Institute of Paleobiology of the Polish Academy of Sciences, Warsaw (abbreviated as ZPAL); and the second, comprised 65 specimens, assembled by K. BIRKENMAJER and housed at the Museum of the Institute of Geological Sciences, Jagiellonian University, Cracow (abbreviated as UJ).

Comparative collection comprising 22 specimens of Recent *Flabellum impensum* SQUIRES has been examined. The collection, assembled by Polish Antarctic Expeditions 1980—1983, at 10 stations (depths from 182 to 600 m) in the vicinity of King George Island (South Shetland Islands) and the Orcades (South Orkneys Islands), is housed at the Institute of Biology, University of Łódź (Poland). A comparative set of specimens of *F. impensum*, *F. areum* and *F. flexuosum* (United States Natural History Museum, Washington) has been examined as well.

The following abbreviations and symbols are used in morphological descriptions and explanations for figures (fig. 3): *d* and *D* — small and large diameter in ellipsoidal sections of corallum, *H* — height of corallum, *s* — number of septa, *sd* — septal density measured at distal calicular edge; *S1*... *Sn* — septa of the first and successive cycles, *IS1*... *ISn* — interseptal spaces adjacent to successive septal cycles; *i* — phase of inception of septa, *w* — phase of widening of IS; angle α — angle between lateral edges of corallum, and angle β — angle between lateral sides of corallum.

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CHARACTERISTICS OF CORAL-BEARING DEPOSITS

The oldest *Flabellum rariseptatum* was found in the Destruction Bay Formation. This formation comprises rocks of psammitic and psephitic fractions and with large-scale oblique bedding, resulting from the reworking of basalts. Some fossiliferous intercalations yield remains of marine fauna and terrestial plants. Corals are not common as a faunistic component, and they have been recorded only from a single locality (fig. 1: loc. 194). Coral-bearing strata include gray-brown, coarse-grained, basaltic sandstones with numerous bivalves in life position, gastropods, redeposited belemnites, and other fossils (BIRKENMAJER 1984).

In glacio-marine sequence of the Cape Melville Formation corals are much more common than in the above mentioned strata. The formation is built of thin-bedded clay sediments,

Table 1

Flabellum rariseptatum Roniewicz et Morycowa, 1985 and the allied species (data after: Squires 1961, 1962*b*, 1963; Squires and Keys 1967; Cairns 1982)

features / species	shape of corallum	fossa	largest coralla		pedicel			septa				Distribution (after Squires 1961, 1963 and Cairns 1982)
			H mm	D×d mm	D mm	septa on basal plate	attachment	in largest coralla	density par 10 mm	notch	granulation	
Flabellum rariseptatum Roniewicz et Morycowa, 1985	trochoid to flabellate	deep	ca. 75	35×90	1.5—3.8	$6S_1+6S_2$	in young stage	$S_{1-6}+nS_7+nS_8$	9—12	present	coarse	L. Miocene: South Shetland Island King George Island, Tierra del Fuego Depth range: external shelf
Flabellum sp. (Squires 1963 : 35)	like *F. flexuosum*, *F. serpuliforme* and *F. gracile*	[lack of data]	27	12.4×7.2	[lack of data]				relatively widely spaced	[lack of data]	coarse	Oligocene (Juliense Group): Argentina
Flabellum areum Cairns, 1982	trochoid to turbinate or campanulate	relatively shallow (see Cairns 1982; pl. 11 : 2.3)	32.5	27.7×20	3.2—5.1	$6S_1+6S_2$	weak in young stage	$S_{1-4}+nS_5$	ca. 12	present	low to moderately tall	Recent: Patagonian shelf, Tierra del Fuego, SE of Falkand Island Depth range: 1647—2229 m
Flabellum thouarsii Milne-Edwards et Haime, 1848	ceratoid to flabellate	relatively shallow	34	33×22	ca. 2.5—3.2		in young stage	S_{1-5}	18—19	present	coarse and irregular	Recent: Patagonian shelf Depth range: 71—305 m
Flabellum flexuosum Cairns, 1982	ceratoid, from straight to scolecoid	shallow (see Cairns 1982, pl. 12 : 10.11)	67	24×20,7	2.7×4.5	$6S_1+6S_2$	attached	S_{1-5}	ca. 20	[lack of data]	fine pointed	Recent: circum-Antarctic and S. Georgia Depth range: 101—659 m
Flabellum curvatum Moseley, 1881	trochoid to ceratoid usually curved	shallow	47	44×30	2.5—3.3		in young stage	S_{1-5}	15—17	present	variable	Recent: Patagonian shelf S. Georgia Depth range: 115—1137 m
Flabellum impensum Squires, 1962	conical to flabellate	very deep	80.2	flabellate: 128×45 conical smaller	3.5—6.0	$6S_1+6S_2$	attached or free	$S_{1-6}+nS_7$	19—22	present	fine	Recent: circum-Antarctic Depth range: 46—2260 m
Flabellum rubrum (Quoy et Gaimard, 1833)	cuneiform	deep	44	D = 48 (corallite flattened)	2—4 (comp. Squires 1963 : text fig. 2)	$6S_1$ (Squires 1963: pl. 2:1)	attached talons present	S_{1-6}	[lack of data]	?	variable	U. Miocene-Recent: New Zealand Depth range: 0—155 m
Flabellum gracile (Studer, 1877)	[no data in the literature available]		29	D = 11 (corallite subcircular)		$6S_1+6S_2$ (see Squires and Keys 1967: pl. 4 : 7	attached pl. 4 : 7	S_{1-4} pl. 4 : 6, 7)	not closely spaced	[no data in the literature available]		Recent: New Zealand Depth range: 96—196 m

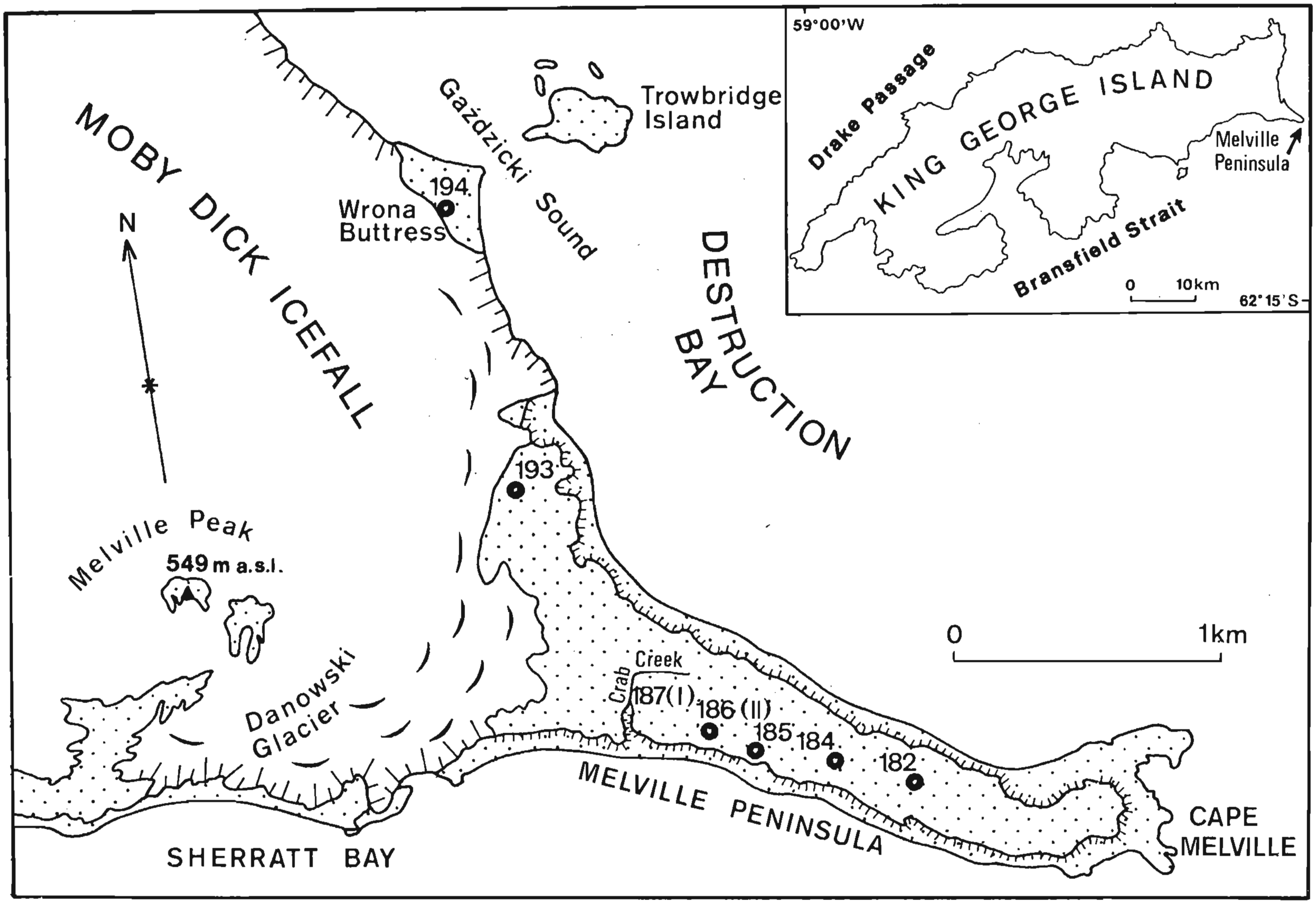

Fig. 1

Location map of *Flabellum* sites at the Melville Peninsula and Wrona Buttress; insert shows location of the Melville Peninsula. Numbers of sites after Birkenmajer (1984, 1987).

mudstones, shaly sandstones, and marly intercalations, displaying dispersed dropstones varying from a few millimeters up to two meters in size. The beds are rich in both autochthonous fauna and recycled fossils (BIRKENMAJER *et al.* 1983). The autochthonous faunal assemblage comprises a single species of coral, large foraminifera, and diatoms (*fide* GAŹDZICKI and WRONA 1982); bivalves, including semi-infaunal ones, often in life position; gastropods (KARCZEWSKI 1987, this volume); polychaete worm jaws (SZANIAWSKI and WRONA 1987, this volume) and tubes; crabs, complete with carapaces as well as crab trace fossils (FÖRSTER *et al.* 1985, 1987 this volume); echinoderms (JESIONEK-SZYMAŃSKA 1987, this volume), and fish remains. The redeposited fossils include Aptian-Albian belemnites (BIRKENMAJER *et al.* 1987, this volume) and Upper Cretaceous calcareous nannoplankton (DUDZIAK 1984).

The studied corals come from six localities exposed on the top of the peninsula plateau. They were found in gray to gray-green (fig. 1: localities 182, 184, 185 and 193) and green-gray or black shales (loc. 187) or greenish siltstones and fine grained sandstone (loc. 186). The accompanying fauna appears more or less differentiated but generally as mentioned above. Corals are found either *in life* position (BIRKENMAJER 1984), i. e. vertically oriented or overturned, lying horizontally in rock layers. Both the smallest and largest individuals come from the locality 187, where the coral-bearing strata are about 6 m thick.

REMARKS ON PRESERVATION AND TAPHONOMY

The pedicel is preserved in only a few specimens. The proximal end is broken off at various heights in the majority of specimens. Complete or partially preserved basal plates are displayed by 31 specimens. Distal parts of coralla, i. e. calicular edges and distal margin of septa, are easily discernible only in a few specimens. Distal margin of septa appears traceable on natural breakage surfaces only. Outer wall surface with noticeable septal furrows is often preserved in fragments. The walls in some specimens display fine transversal growth folds.

The original microstructure of the skeleton is fairly well preserved in numerous specimens

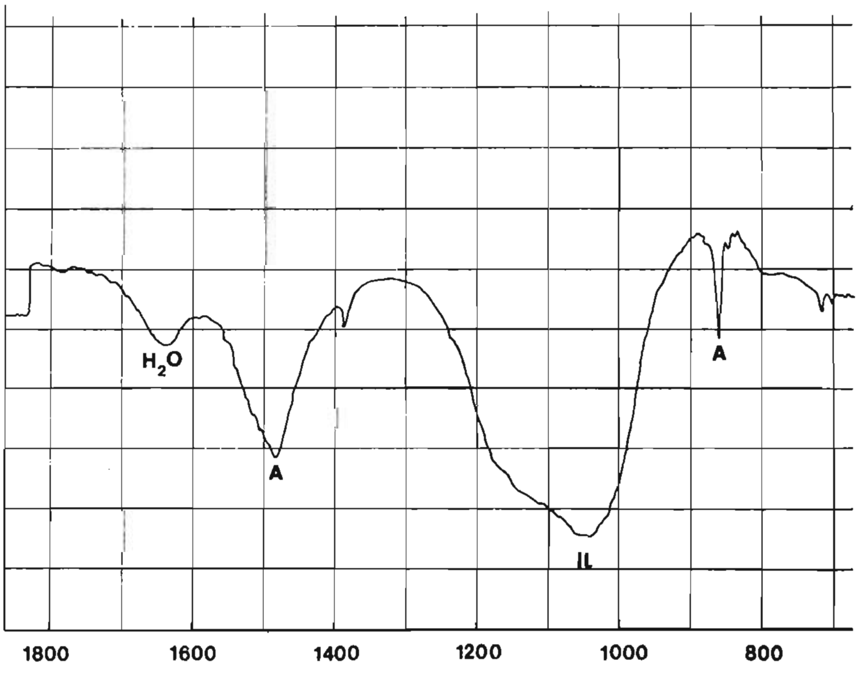

Fig. 2

X-ray diffraction pattern of the skeleton of *F. rariseptatum*: *A* aragonite, *Il* illite, H_2O molecular water.

as preservation of aragonite (fig. 2) has been facilitated by deposition in fine, clay-mudstone sediment. Microscopic study of thin sections clearly shows traces of small trabeculae along the median septal line, fibrous structure of stereome and its successive growth layers (pl. 22 : 6). Some specimens show the origination of a fissure in the place of the median septal plane and in the wall (pl. 20 : 5*b*). This feature was formed after dissolution of the skeleton, in parts originally built of fine trabeculae. This causes a break-up of the skeleton along the median septal plane and the splitting of the wall (pl. 20 : 5*a*). When septa disintegrate, inner surfaces show fine outlines of almost vertically oriented thin trabeculae, and growth lines of septum, parallel to distal and inner edges (pl. 21 : 4, 5*ab*, 6). Because of the above mentioned splitting, specimens when extracted from the rock often loose the outer layer of the wall resulting in marked changes of original dimensions, especially in the case of small forms. The specimens often display traces of destruction by organic and other agents, some of which may be interpreted as formed prior to burial, while in others undoubtedly after burial. Specimen ZPAL H VII/84 clearly displays traces of regeneration on the distal parts of septa, demonstrating mechanical damage incurred before death. Activity of organisms in the walls and septa of the coral skeleton is very common (pl. 20 : 3; fig. 5). It is represented by tubular channels, 0.5 mm in diameter and aligned most

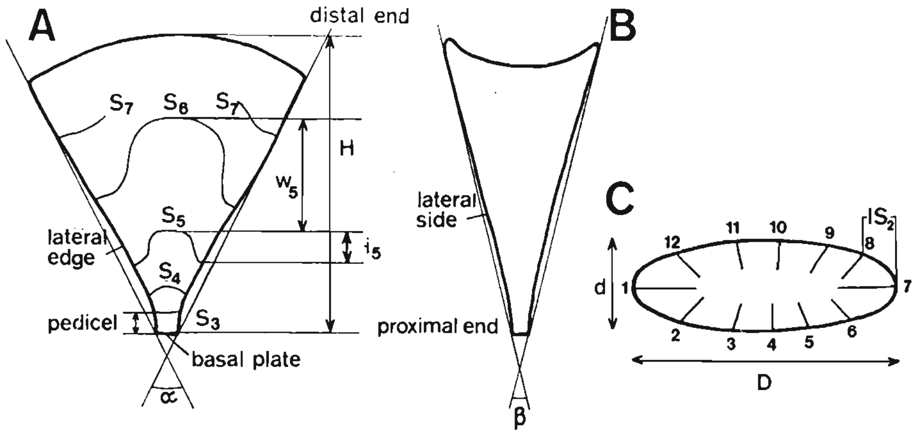

Fig. 3

Flabelloid corallum: terminology, symbols and abbreviations used. A, B corallum in side and in edge views: *H* height, S_{1-7} inception lines: the lines linking inception places of septa of particular cycles, i_n phase of inception of the successive septal cycles, w_n phase of widening of interseptal spaces, α angle between lateral edges, β angle between lateral sides; *C* corallum in calicular view: *d* and *D* — smaller and greater diameters, *1—12* septa of the 1st and 2nd cycles. *ISn* — interseptal spaces resulted from the inception of successive septal cycles.

often with direction of growth of the corallum. At least some of them seem to be made during the life of the host organism. The surface of some specimens is strongly damaged in a way resembling the effects of chemical corrosion. The outer layer of the skeleton appears to be destroyed, and sediment infills depressions. Skeleton damage after burial is a result of compaction of sediment. Such specimens are flattened or fractured, with crushed distal part and individual skeletal elements translocated in relation to one another.

Birkenmajer *et al.* (1983) and Birkenmajer (1984) reported many corals in life position, i. e., set vertically in the sediment. Specimens which were overturned are represented as well in outcrops. For example, in the collection, in 31 rock samples yielding 127 corals from the locality 187, corals were overturned, randomly arranged. Remarkable is the high density of specimens when observed in rock samples: more than 5 overturned young individuals can be distributed on the surface of 20 cm².

Some of the above mentioned samples contained specimens in different stages of growth. Eight samples yielded from two to six individuals each, representing the two earliest growth stages of corallum (see the ontogeny), accompanied by not fully grown individuals. These represent early phases of adult growth attaining greater diameter (*D*) of about 30 mm. Other, single corals in the collection represent relatively young individuals with greater diameter beginning with 20—40 mm, as well as rare fully grown adults.

DESCRIPTION

Genus *Flabellum* Lesson, 1831
Flabellum rariseptatum Roniewicz et Morycowa, 1985
(figs. 3—10; pls. 19—24)

1978. *Flabellum* cf. *cuneiforme wailesi* Conrad; Malumian et al.: pl. 1 : 8*ab*
1982. Solitary coral *Flabellum*; Gaździcki and Wrona: fig. 6*a*, *b*
1983. Solitary coral of the genus *Flabellum*; Birkenmajer *et al.*, fig. 4*b*, *c*
1985. *Flabellum rariseptatum* Roniewicz et Morycowa: 101, fig. 2—4, pl. 1 : 1—6, pl. 2 : 1—7

Material. — About 360 isolated specimens, some arranged in clusters within rock samples No. ZPAL H VII/1—264, and 65 specimens UJ P 125/1—65.

Dimensions (in mm):

	d	D	H	s	Remarks
Adult conical specimen ZPAL H VII/89	46	52	e. 65	e. 120 (S5+nS6)	distally damaged, possible complete S6
Adult flabellate specimen ZPAL H VII/57	e. 30	90	e. 70	e. 200 (S6+nS7+nS8)	specimen damaged at one side

Description. — Adult individuals are highly variable in shape ranging from steep-walled, slender (trochoid) forms with angle from 30° to 40°, through intermediate (turbinate) ones with various modifications, to those with angle α up to 90—110° (flabellate ones). Angle β very similar in all the forms, usually falling in the interval 30°—40° (fig. 3). Calices are ovate to flattened ellipsoidal (fig. 4; pls. 19, 20) in cross section, rarely subcircular in adult specimens. Fossa narrow, long, and deep. Juvenile individuals (below 10 mm in diameter) differ from the adult in uniform shape: slender, trochoid, angle α from 24° to 45°, with subcircular calice (pl. 23). Calice widens and angle markedly changes along with the appearance of the S4 and successive septa. Increase of diameters (fig. 7) and changes in shape of calice appear related to increase in number of septa and widening of interseptal spaces (IS). In flabellate individuals IS first begin to widen in systems close to lateral edges, remaining unchanged in the other ones, and in individuals ovate in cross section, the spaces appear subequal along the whole calicular edge. Septal density is about 10—12 per 10 mm, decreasing to 8—10 per 10 mm when IS become the widest.

Calices proximally rapidly narrowing and passing into thin, short, cylindrical pedicel. Basal plate very thin, circular or ovate in outline, from 1.5 to 3.8 mm, most often 2—3 mm in diameter.

Calicular edge even and surface of corallum smooth, except for fine chevron growth lines (pl. 24 : 7). Septal furrows visible; fine ridges sometimes developed at the extension of the S1—S3 (pl. 19 : 3). Corallum rounded at lateral edges; surface either smooth in that area or tuberculate. The tubercles represent repeated widenings of calice, separated by constrictions, and they reflect periodic disturbances in growth of corallum (fig. 9).

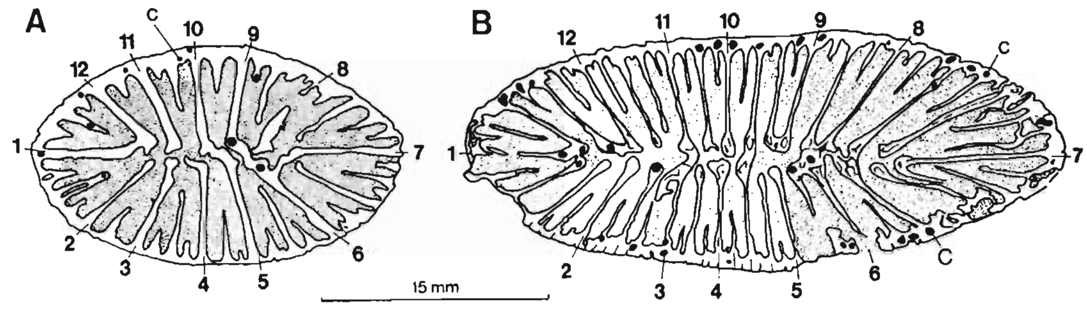

Fig. 4
Transverse section of a conical (A) and flabellate (B) corallum of *F. rariseptatum* at the level of distal columellar region: differences between specimens in development of septal cycles are displayed; *c* infaunal tubes. ZPAL H VII/245 and 68

The septa are in 6 cycles with an incomplete 7th cycle, and occasionally septa of the 8th cycle. Differences in length of septa in each cycle are best discernible in adult nonflabellate individuals with S1 and S2 uniform in length, the S3 somewhat shorter, the S4 up to two-thirds of S1 in lateral systems and shorter elsewhere, the S5 up to a quarter of the length of the S1, and septa of the remaining cycles developed close to the wall. In flabellate individuals, of S3 and S4 attain the S1 length those in systems close to lateral edges. In other systems the S3 septa are subequal with S1, whereas S4 are varying in length but usually shorter than S1 (fig. 4).

In the calice, septa are nonexert and thin, about 0.1—0.2 mm up to 0.4 mm thick (pls. 20 and 21). Surface of septa is ornamented with fine granules arranged in rows roughly parallel to distal edge. Granules are sharp, varying in height and irregularly spaced. Septal blades widened at the peripheral and inner edges. Distal edge is subhorizontal or slightly convex in less flattened specimens, with a clearly marked shallow notch close to the wall (pl. 21 : 1).

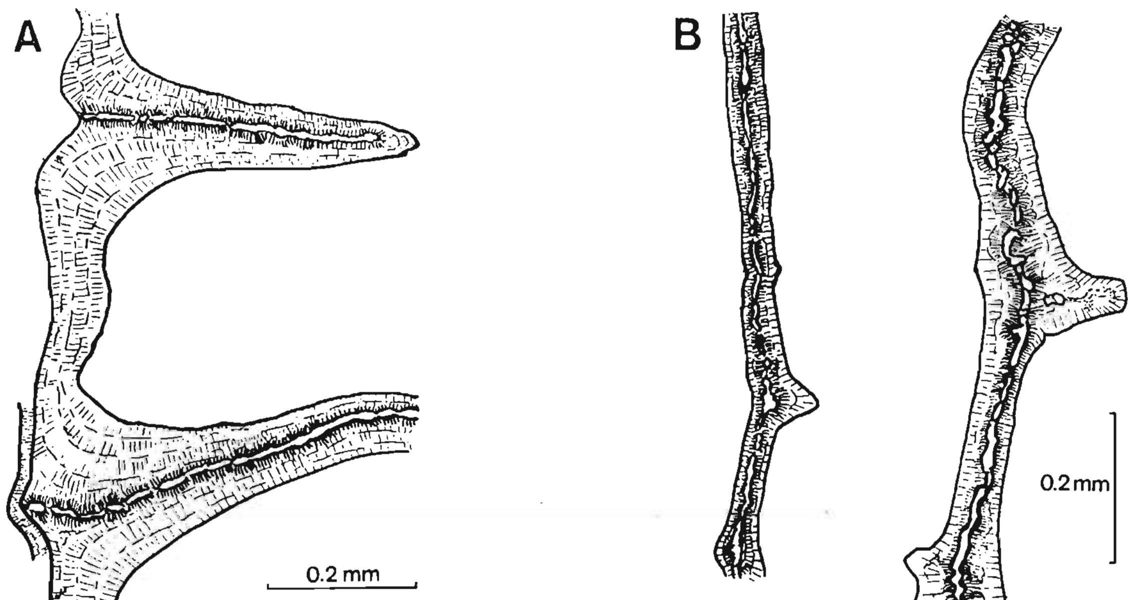

Fig. 5
A and *B* — wall and septa of *F. rariseptatum* in cross section. Traces of original microstructure are visible. Small-trabecular middle portion of the septal blade is partially leached. Growth lines in stereomal portion are well marked. UJ 125P/27.

The notch is sometimes denticulate but the rest of distal edge is smooth. In flabellate specimens, the edge rather gently slopes and the notch is not developed (pl. 21 : 2*a*, 3). Inner edge is vertical, smooth, with thick projections at the bottom of the fossa (pl. 21 : 2*b*). The projections are regularly diverging, connected with each other and forming loose, spongy columella (pl. 21 : 2*b*; pl. 22 : 1,4). The columella originates at the earliest growth stages (pl. 24 : 5). It is initially formed by S1 and S2. In unflattened individuals, S3 take part in formation of columella in systems close to lateral edges, and in flabellate forms — along the whole calicular outline. S4 take part in this only in flabellate forms.

Inner surface of the wall in all IS displays some rows of scars: 3—4 per 1 mm (pl. 24 : 1—3), single in narrow spaces and double and situated close to septum in wide ones. The same structures are known in *F. basteroti* MILNE-EDWARDS et HAIME, 1848 (CHEVALIER 1961: fig. 139) and other Caryophylliina (SORAUF and PODOFF 1977: 6, pl. 4: 6, 7, 8). The structure undoubtedly corresponds to those reported from hermatypic corals by WISE (1970), and representing traces of attachment of soft tissue (desmocytes) to skeleton (WISE 1970; SORAUF and PODOFF 1977). The scars in *F. rariseptatum* are large, deep, semilunar, with corners directed upwards, regularly developed, and traceable from basal plate level (pl. 24 : 3). Some attachment scars may also occur at surface of septa (pl. 24 : 4), but in the latter case they appear highly irregular in outline.

Microstructure. — Examined material contribute a little to the knowledge on the microstructure of skeleton of the genus *Flabellum*. Thin-trabecular mid-septal line and thick stereomal deposit constituting septal flanks and the internal portion of the wall are observable (fig. 5; pl. 22: 2, 5, 6). Unfortunately, the wall is difficult to examination due to poor preservation of its external portion.

Ontogeny. — In the development of corallum several stages can be differentiated in the formation of septal cycles: 1. stage of 12 protosepta, 2. stage of three cycles of septa, 3. stage of four cycles, and 4. stage of five and more cycles. In each of these stages there are differentiated two phases: (i) phase of inception of septa (*i* — fig. 3), either simultaneous or extended in time and observable at the distance of a few to about a dozen millimeters as measured along growth axis of corallum, and (ii) phase of widening of interseptal spaces (*w* — fig. 3) taking place after successive phase of inception, and ending with appearance of septa of the next cycle.

Fig. 6 shows schematically some examples of septal inception. Intraspecific variability of shape of the inception lines is presented in fig. 7. The shape of the line rarely is regular and vary on both sides of the same corallum (fig. 7 : C′ and C″).

Stage of 12 protosepta: Corallum is composed of basal plate, wall, and 12 protosepta (S1 and S2) growing from the plate (pl. 23: 4, 7, 8, 11). Four of preserved 11 complete plates arr ovate in shape, and seven — circular (pl. 23: 7, 8, 11). Basal plate is convex upwards at the centee or, sometimes, furrow-like (pl. 23: 7b; pl 24 : 6), and its outer edge is sharp (pl. 5 : 2). Protosepta are differentiated at the level of the plate: six reach the center (S1), and six other, lying between them (S2), are somewhat shorter (pl. 23 : 11). The latter becomes markedly shortened a few millimeters above the level of the plate. Ovate plates are 1.5×2.0 mm and 1.5×3.0 mm in size, and circular — from 2.0 to 3.8 mm in diameter. Above the level of the plate, diameter of corallum may remain unchanged or slightly decreases which is followed by its slow growth (pl. 23 : 4, 6, 7*a*).

Stage of 3 cycles: Inception may start at H equal 1.5 mm but usually at H = 3 or 4 mm. It is either almost simultaneous or extended in time and traceable at 3—4 mm distance (pl. 23: 4, 5, 7a, 9, 11). Close to the end of the phase, the corallum is from 4 to 6 mm high and from 3 to 5 mm in mean diameter (pl. 24 : 7). Differentiation of larger and smaller diameters begins when diameter exceeds 5 mm.

Stage of 4 cycles: Inception of S4 begins at different height and diameter but usually when

D exceeds 7 mm (pl. 23 : 10). It is either simultaneous or extended in time and traceable at 5 mm or longer distance, to end at D varying from 10 to 14 mm. Widening of IS is observable in various intervals of height. Coralla regularly conical in shape remain at the 48-septa state for a long time, even at a diameter of 17×22 mm and H over 20 mm, while the flattened ones — until a diameter of 8×12 and H around 10 mm.

Stage of 5 and more cycles (figs. 6 and 7): The stage of corallum with 5 cycles of septa begins at various H and D. Corallum becomes finally either conical or flabellate in shape depending at which height the cycles 5th and 6th begin to develop and how quickly they are completed. The phase appears markedly accelerated close to lateral edges and extended in time at sides, especially in flabellate forms. Differentiation of morphological proportions of corallum tranverse section caused by variability of inception pattern is illustrated by a diagram showing relations between d and D in the sample examined (fig. 8).

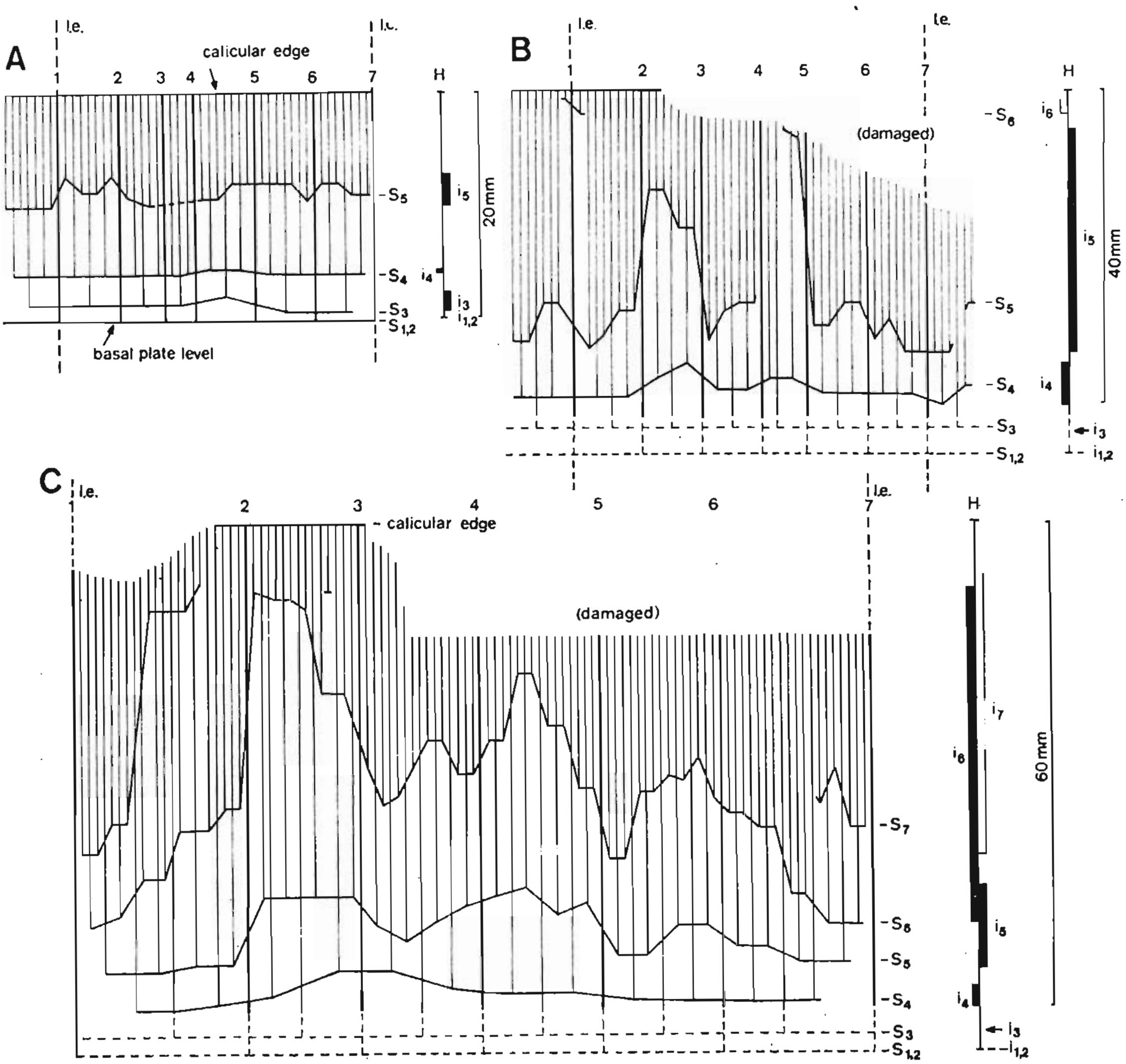

Fig. 6

Scheme of inception of septa of successive septal cycles in seven half-systems of conical and flabellate specimens of *F. rariseptatum*, lateral view: *A* regularly conical specimen, ZPAL H VII/195 (presented in pl. 19 : 5); *B* campanulate specimen, ZPAL H VII/43; *C* flabellate specimen, ZPAL H VII/19. Compare fig. 7. For explanation see fig. 3. Height in scale.Each scheme is accompanied at its right by a diagram showing relationships of succeeding phases of septal inception (i_{1-7}) marked on the common axis corresponding to the corallum growth axis.

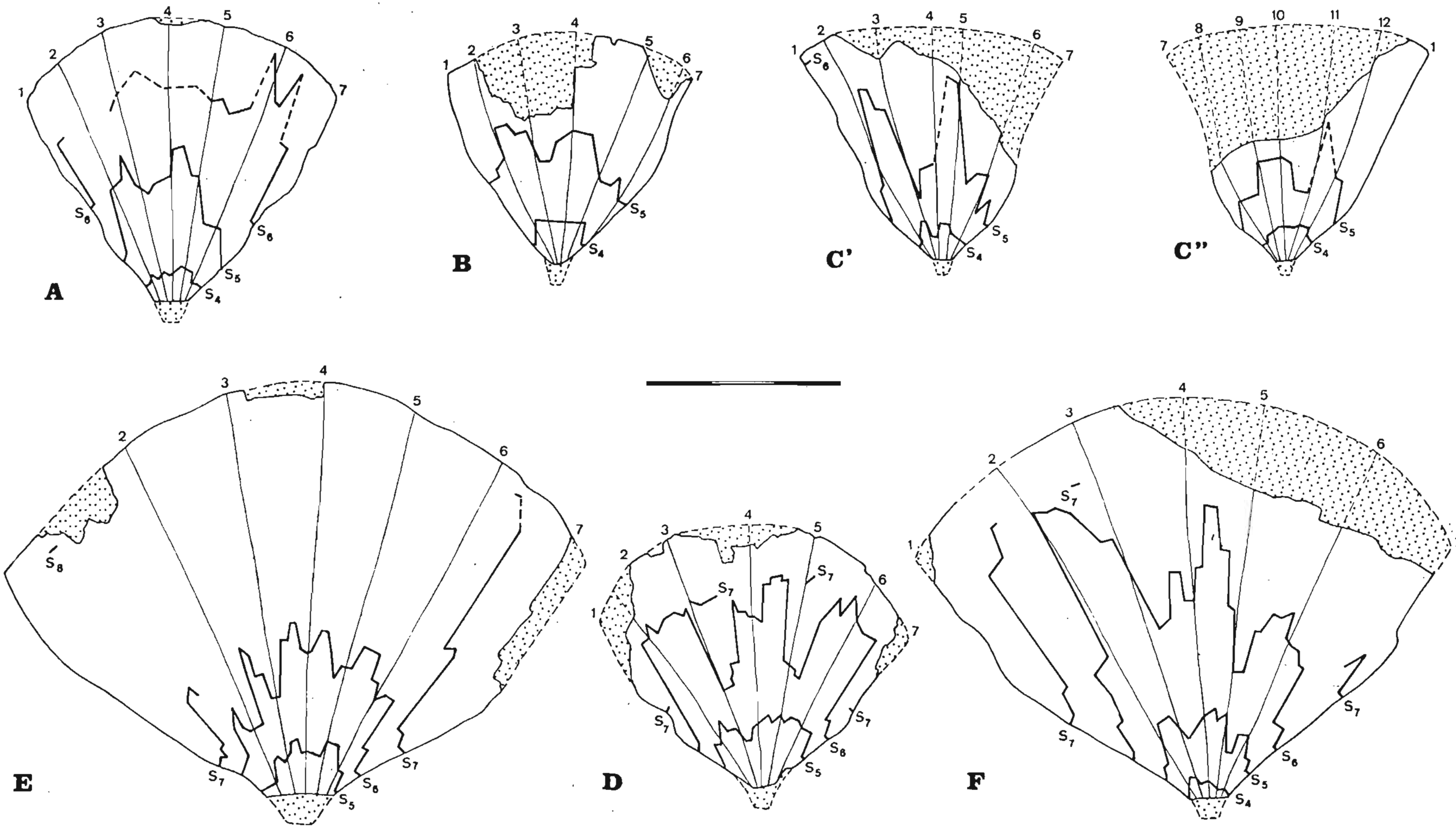

Fig. 7
Variability of septal cycles distribution in *F. rariseptatum* in corallites of different shape. *A* regularly conical specimen, ZPAL H VII/237; *B* irregularly conical specimen, ZPAL H VII/79; *C'* and *C''* campanulate specimen seen from opposite sides, ZPAL H VII/43; *D* small flabellate specimen with S7 septa accelerated in comparison with *E* and *F*; *E* flabellate specimen, ZPAL H VII/57; *F* flabellate specimen ZPAL H VII/19; *l. e.* lateral edge, for other explanation see fig. 3. Compare fig. 6. Scale bar is 30 mm.

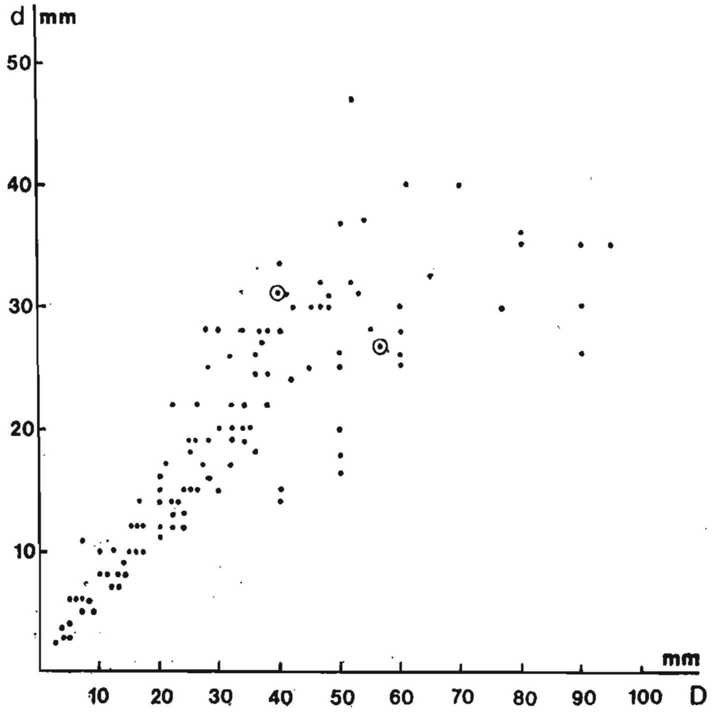

Fig. 8
Correlation of diameters d and D in *F. rariseptatum*; simple dots — specimens from the Cape Melville Formation, encircled dots — specimens from the Destruction Bay Formation.

(i) Development of conical forms: Inception of S5 begins at H varying from ca. 15 to 20 mm, and D ca. 15 to 20 mm. It is extended over distance from 10 to 30 mm, fairly uniformly along the whole outline. The 6th cycle is incomplete: S6 appear close to lateral edges and irregularly, in pairs, in the remaining systems. The phase of S6 inception starts at D from 25 to 40 mm.

(ii) Development of flabellate forms: Inception of S5 starts at H somewhat over 10 mm and D of 8×12 mm or similar. It is extended over 5—10 mm distance, ending at D of 12×29 mm or similar. Widening of IS5 appears accelerated at 5 mm distance close to lateral edges, in comparison with slow widening at 20—30 mm distance at sides. The 6th cycle clearly interferes with phase of incision of the fifth one. S6 first start to insert close to lateral edges. Inception of S6 is extended over distance from ca. 25 mm to 35 mm or more. It starts at D of 12×20 mm or similar, to end at D of 20×40 mm (or in a single case, at 25×60 mm). The 6th cycle appears complete. IS6 attain maximum width first at lateral edges, remaining very narrow for a long time elsewhere. Phase of inception of S7 may interfere with that of S6. S7 appear at D from 12×30 to 22×40 mm, in varying number, first close to lateral edges, and then in pairs, irregularly in remaining systems. The 7th cycle is incomplete, its development being interrupted at early inception phase. Rare S8 have been found close to lateral edges, in a single corallum only. Along with appearance of S7, the zone of the widest IS6 and IS7 gradually widens to comprise the whole calicular outline.

Variability. — The available material comprises two morphotypes differing in frequency: very common conical morphotype and its varietes (trochoid, turbinate, campanulate, etc.), and rather rare flabellate one. The conical morphotype is characterized by inception of septa extended in time, septal apparatus consisting of septa of five cycles and incomplete S6, subhorizontal distal edge and well-developed notch. The flabellate morphotype shows accelerated inception of septal cycles, sloping septal edge and (therefore) lack of notch, and septal apparatus of adult individuals also composed of complete S6, incomplete S7 and even some S8 (fig. 7).

Features common for both the morphotypes include: thin pedicel, twelve protosepta, smooth septal edges, coarse granulation, wide interseptal spaces in adult individuals (sd ca. 10/10 mm), and semilunar, deep attachment scars, which may be treated as a basic set of specific features. Morphotype differentiation in *F. rariseptatum* resembles that in *F. impensum* (compare CAIRNS 1982: 40). In the latter, different forms occur either separately, in different populations, or together. The variability in shape of corallum is explained in terms of effects of local changes of environment, in which individual agents (e. g. type of bedrock or pattern of currents) may change at small distances (CAIRNS *l. c.*). Both morphotypes of *F. rariseptatum* may co-occur which is shown by their presence in rock samples yielding clusters of coralla.

It may be expected that differences between the morphotypes in such material as analysed here will appear greater than in the case of samples from one or even several coeval populations. This is connected with the fact that the studied material comprises possibly numerous populations of different age. The age differences are inevitable as the material has been collected in various localities distant from each other, distributed at erosional surface of layers of coral-bearing complex a few meters in thickness. Significant differences between end members of the populations are very large, which is reflected by e. g. angle α varying from 30° to 110°.

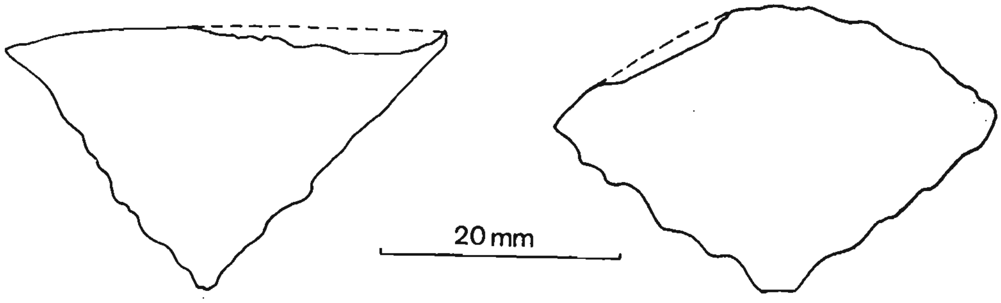

Fig. 9
Corallum shape of (left) the specimen from the Destruction Bay Formation, King George Island (ZPAL H VII/263), and (right) the specimen from the Carmen Silva Formation, Tierra del Fuego (drawing after a photograph presented by MALUMIAN *et al.* 1978: pl. 20 : 8b).

Besides the above discussed major differentiation into distinct morphotypes, there is also observed marked variability in organization in conical morphotype. In extreme cases, development of the columella in trochoid forms is limited to parts situated close to the basis of corallum, and fossa above columella is relatively wide. Cross sections of such coralla markedly differ from the typical, especially when stereome is well developed.

Comparisons of structure of coralla from stratigraphically most distant localities in the section, i. e. localities 194 (Destruction Bay Formation) and 187 (Cape Melville Formation), showed marked differences in development of tubercles at lateral edges. A single well-preserved corallum from the Destruction Bay Formation displays seven fine tubercles, and specimens from the Cape Melville Formations — single tubercles if ever. The available figures show that the morphotype with tubercles (fig. 9) is known from conglomerates of the Carmen Silva Formation, Lower Miocene of Tierra del Fuego (MALUMIAN *et al.* 1978, pl. 1 : 8*ab*). The strata, formerly dated at the Oligocene, were recently assigned to the Lower Miocene by CODIGNOTTO and MALUMIAN (1981). It follows that the morphotype with tubercles is related to medium- and coarse-clastic sediments, and that without tubercles — to the fine-clastic and that the presence of tubercles is determined by ecologic conditions.

Besides the above mentioned differences in shape and structure, the coralla also vary in their ability to form stereome in the proximal part. Because of that, some coralla are infilled with stereome close to the base only (at D below 10 mm), and others in large interval of height and even at D ca. 20 mm.

Distribution. — Lower Miocene: King George Island (South Shetland Islands, West Antarctica) and Tierra del Fuego (South America).

ENVIRONMENT AND MODE OF LIFE

Life position. — Coralla observed in outcrops were set vertical or overturned. The former has undoubtedly been the natural position as growth axis is straight in over 400 available specimens and only one specimen (diameters 15×30 mm) appears proximally incurved, in the way resembling *F. curvatum*. Adult individuals lived partly buried in sediment. The buried proximal end was infilled with stereome so as to act as an anchor.

Sides of coralla were accessible for epifauna, which is evidenced by presence of encrusting bryozoans at both sides of flabellate coralla or attachment of conspecific initial coralla (pl. 23 : 11). Moreover, the majority of infaunal channels made in septa and wall follow vertical direction, which may indicate their origin during life of a coral. When overturned individuals could not survive which is indirectly shown by the rarity of forms incurved during life. Coralla long exposed at sea floor after death were subjected to corrosion. It follows that the mode of life of these corals was similar to that of such species as *F. impensum* SQUIRES, *F. thouarsii* MILNE-EDWARDS et HAIME, and *F. areum* CAIRNS, differing from that of *F. curvatum* MOSELY and *F. flexuosum* CAIRNS, resting on sea floor, or *F. rubrum* (QUOY et GAIMARD) attached to substratum.

Analysis of proximal ends showed that attachment to stable substratum was not an undispensable prerequisite for development of *F. rariseptatum*. From over 30 juvenile specimens with preserved basal plate, one was found attached to rock fragment, three to surface of adult coralla, and the remaining ones display concave basal plate infilled with sediment. It follows that they either settled on consolidated sediment surface or attached to unstable objects to sink in sediment along with increase in weight. In two small individuals (ca. 5 mm) growth axis is oriented obliquely to basal plate. The species is characterized by negative geotropism, so such orientation of the axis indicates that the individuals lived attached to objects oriented oblique to sea floor surface, e. g. to sides of bottom-dwelling organisms.

The observations made by SQUIRES (1962*a*) showed that larvae of *F. curvatum* (or *F. thouarsii* as corrected by CAIRNS 1982 : 34), at least those from final stages of a breeding season, may not be very active and quickly settled on the sea floor. A mode of development similar to the above mentioned would explain the occurrence of individuals of *F. rariseptatum* of the same age in clusters in the available material. The low dispersion ability of larvae led in places to a heigh density of corals on the sea floor.

Depth and turbulence of water. — In its morphological variability *F. rariseptatum* resembles *F. impensum* SQUIRES, known from wide range of water depth, from 46 to 2260 m. Such depth range covers the whole range for all species of the *thouarsii*-group (see CAIRNS 1982 : 63), except for *F. rubrum*, known from depth between 0 and 155 m (see SQUIRES 1963). Some populations of *F. impensum* are morphologically homogeneous, and others — heterogeneous. Although evidence for dependence of distribution of morphotypes on environment is still unsatisfactory, it is assumed that individual morphotypes reflect local differences in environmental conditions (CAIRNS 1982). Eurybathic character and morphological variability of *F. impensum* evidence its abilities to adaptation. Per analogy it may be assumed that *F. rariseptatum* was also a plastic species and one may expect its presence in sediments from shallow- to deep--water. In the present case the composition of benthic organisms and the nature of ichnofauna accompanying *F. rariseptatum* indicate open-marine, moderately deep environment of the outer shelf zone (BIRKENMAJER 1982*b*, 1984). Rich benthos (including semi-infaunal bivalves in life position), horizontal crab burrows, and the vertical growth position of corals evidence low water energy. In turn, chaotic burial shows that periods of quiet sedimentation were often suddenly broken by episodes of water turbulence. The bulk of the corals were buried before attaining maturity. However, some others undoubtedly represent adult stages and possibly even maximum dimensions as they attained maximum width of interseptal spaces along major part of calicular edge. Dimensions of coralla may serve as a measure of length of quiet periods. In the analysed case the dimensions indicate that the environment was subjected to disturbing events irregularly and sometimes in so short time intervals that the individuals did not reach maturity.

The disturbances may be explained as due to rapid movements of water, which could take place from time of time, or quakes of sea floor, undoubtedly taking place in this tectonically active zone (cf. FÖRSTER *et al.* 1987, this volume). Effects of such disturbances are not equally disadvantageous for the whole benthic fauna. A part of vagrant benthos could survive (e. g. crabs and some bivalves), whereas corals did not escape extinction.

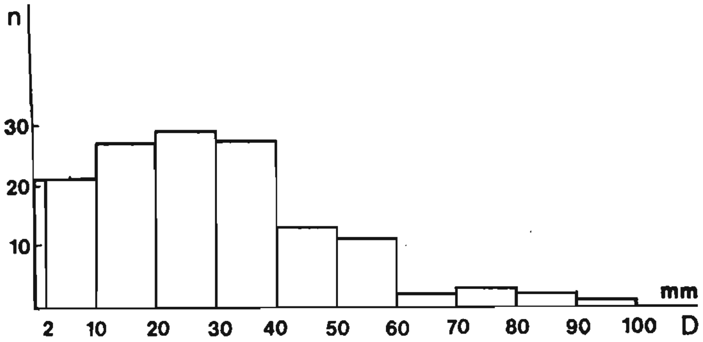

Fig. 10
Frequency distribution of greater diameter (D) in the collection of *F. rariseptatum* examined.

The collection comprises individuals of all growth stages from the initial basal plate with 12 protosepta up to large coralla with complete S6 and sporadic S7 and S8 septa. Dimensions increase in this species rather regularly with age of coralla. Thus, age structure of the collected corals (which, however, do not represent a fossil population, see p. 13) is shown in fig. 10 which displays frequency distribution of calicular diameter D. A group of specimens representing the earliest growth stages and falling in the class size of 2 to 10 mm appears relatively well represented, as also do those falling in the 20—30 mm and 30—40 mm size and characterized by completion of the S5. The other size classes, up to 90 mm or more, are adults and are relatively rare.

Survival. — Frequency distribution of great calicular diameter (D) indicates (fig. 10) the highest mortality of individuals falling into classes with D below 40 mm, i. e. not fully grown ones. Striking is high analogy in the size-frequency distribution of Recent *Balanophyllia elegans* sample collected from rubble channels (FADLALLAH 1983: fig. 1) and that of *F. rariseptatum* under study. The analogy appears despite of different agents influencing the post-mortem selection in the first and the second of the samples. In the case of *B. elegans* juvenile skeletons were infrequent in the rubble having been presumably breaked up before sedimentation. In the case of *F. rariseptatum* we deal with individuals the bulk of which died in result of sudden events and not any other reasons, and have been suddenly buried *in situ*, without transportation or size selection. Here the thinnest skeletons may have disappeared due to diagenetical, post--depositional changes.

In time of quiet sedimentation, possibilities to survive were limited by several factors. Among others, an important factor would be the character of the substratum to which larvae became attached (surface of sea floor sediment, surface of slowly decaying organic remains, fine pebbles, shells and other skeletal fragments) and the mode of attachment (sometimes disadvantageous for attaining vertical life position and, therefore, for further growth).

AFFINITIES WITH THE *THOUARSII*-GROUP OF SPECIES

Among the species of *Flabellum* living to-day in the Antarctic and sub-Antarctic zone there may be differentiated quite a large group with several features of structure in common. This makes possible its treatment as a natural group. It comprises three species known from South American shelf (*F. thouarsii* MILNE-EDWARDS et HAIME, *F. curvatum* MOSELEY, and *F. areum* CAIRNS), two circum-Antarctic ones (*F. impensum* SQUIRES and *F. flexuosum* CAIRNS and two endemics from New Zealand (*F. rubrum* (QUOY et GAIMARD) and *F. gracilis* STUDER).

Here we do not follow SQUIRES (1962, 1963) as we regard *F. thouarsii* as more characteristic of this group than *F. rubrum*. The latter species appears rather atypical, being not characterized by 12-septal initial stage common within the group, but the 6-septal stage, and having the ability to secrete external attachment skeletal projections, unknown in other species of this group.

Individual species of the group markedly resemble one another in morphology, which often results in difficulties in specific identification. This in especially the case of species with a wide morphotype spectrum (CAIRNS 1982). Extensive morphological study and ecological characteristics of species of this group (*F. rubrum*, *F. impensum*, *F. thouarsii* and *F. curvatum*) were given by SQUIRES (1958, 1961, 1962*b*, 1963) and SQUIRES and KEYE (1967), and more recently descriptions of species and revisions of earlier identifications as well as geographic distribution and depth ranges were given by CAIRNS (1982).

Features common for the whole group includes: smooth surface of corallum, ovate calice with a marked tendency to strong flattening, relatively thin pedicel, at least five cycles of septa, a tendency to have a notch at the distal septal edge, and development of a rather feeble columella.

The relation between the above group and other species of the genus *Flabellum* appears insufficiently known. WELLS (1958, *fide* CAIRNS 1982) noted similarity of *F. antarcticum* GRAVIER, 1914 (*recte F. flexuosum* CAIRNS, 1982) to North Atlantic *F. serpuliforme*. This view was subsequently accepted by SQUIRES (1963) and CAIRNS (1982). The group undoubtedly also comprises fossil *Flabellum* sp. from the Oligocene of Argentina, similar to *F. antarcticum* GRAVIER (*recte F. flexuosum* CAIRNS, see CAIRNS 1982), i. e. species with very simple structure, according to SQUIRES (1963).

The affinity of *F. rariseptatum* to representatives of the above group is indicated by similar morphology of corallum and, possibly, ontogeny. However, the latter feature may be in common with some species only. For example, *F. rubrum*, i. e. the only species in which early skeletal stages have been studied in detail (SQUIRES 1963), displays a basal plate with 6 protosepta (S1) in comparison with 12 (S1 + S2) in *F. rariseptatum*. In turn, 12 protosepta may be traced in at least three other species of the group: *F. impensum*, as well as *F. flexuosum* CAIRNS and *F. areum* CAIRNS (personal observations, compare also CAIRNS 1982: pls. 11 and 12). Pre-skeletal stage in larvae of *F. curvatum* MOSELEY (SQUIRES 1962*a*, *recte F. thouarsii* according to CAIRNS 1982: 34) is characterized by well marked twelvefold symmetry in body organization, differentiation of mouth, tentacles and a pedal disc. It follows that the stage of development achieved by larvae before formation of a basal plate is so advanced that acceleration of second cycle of septa appears probable.

From all the above mentioned species of the *thouarsii*-group, *F. rariseptatum* RONIEWICZ et MORYCOWA is most similar to *F. areum* CAIRNS (table 1). Young, conical forms of the former up to H 30 mm, i. e. at the stage of formation of S5, are very similar to the largest of the hitherto described individuals of *F. areum* in shape, dimensions, number and density of septa (in *F. areum* maximum calicular diameter equals 20.0×27.7 mm at H 21.2 mm cycle S5 is incomplete, and sd = 12/10 mm), and in number of protosepta on basal plate (see CAIRNS 1982: pl. 11 : 1, 5). The two species are similar in mode of attachment of coralla. *F. rariseptatum* differs from *F. areum* in markedly thinner pedicel (3.2—5.1 mm thick in the latter), as well as in subhorizontal course of the distal septal edge, deeper fossa and subvertical inner edge of septa. Taking into account similarities in morphology and geographic ranges, the two species differing in stratigraphic distribution may be interpreted as directly related with one another in phylogeny. *F. rariseptatum*, variable in morphology, may represent an ancestral form of morphologically uniform *F. areum*. In the latter, the morphology has been simplified, limited to one of the morphotypes only, and ontogeny shortened in comparison with its ancestral species, which is reflected in septal cycle reduced from seven-eight to six.

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EXPLANATIONS OF PLATES 19—24

All specimens are from Melville Peninsula; Cape Melville Formation, Lower Miocene with the exception of that in pl. 19: 13 which is from Wrona Buttress; Destruction Bay Formation, Lower Miocene.

PLATE 19

Variability of corallum shape in *Flabellum rariseptatum* RONIEWICZ and MORYCOWA, 1985

1. Turbinate corallum damaged distally and proximally, with exfoliated wall, *a* side and *b* proximal views; ZPAL H VII/214, × 1.
2. Flabellate corallum in side views. Distal edge partially preserved, proximal end abraded; syntype UJ 125P/26, × 1.
3. Turbinate corallum in side view, damaged distally and proximally, with abraded wall; ZPAL H VII/66, × 1.
4. Turbinate corallum in *a* side and *b* proximal views. Ribs on the wall developed at S1—S3 septa, wall abraded, corallum proximally damaged; ZPAL H VII/218, × 1.
5. Regular turbinate, complete corallum; ZPAL H VII/195, × 1.4.
6. Turbinate corallum in *a* side and *b* proximal views; specimen damaged distally and proximally, with partly abraded wall; ZPAL H VII/35, × 1.
7. Trochoid corallum in longitudinal section, proximal end broken; UJ 125P/22, × 2.
8. Turbinate corallum in *a* side and *b* proximal views, with proximal end slightly damaged; ZPAL H VII/202, × 1.

9. Juvenile turbinate corallum distally slightly damaged and with exfoliated wall: *a* side and *b* distal views; syntype UJ 125P/1, × 2.
10. Flabellate corallum slightly damaged proximally: *a* side and *b* proximal views; ZPAL H VII/150, × 1.
11. Large turbinate corallum strongly weathered and damaged at proximal and distal ends; syntype ZPAL H VII/89, × 1.
12. Large flabellate corallum broken at proximal end; syntype ZPAL H VII/57, × 1.
13. Corallum largely opened distally with tuberculate lateral edges; ZPAL H VII/263, × 2.

1, 3—6, 8,10—12: loc. 187; 2, 7: loc. 182; 9: loc. 185; 13: loc. 194

Photo G. Podbielska

PLATE 20

Coralla of *Flabellum rariseptatum* RONIEWICZ et MORYCOWA, 1985 in transverse sections

1. Distal calicular sector, septa thin; ZPAL H VII/1, × 2.
2. Deep calicular sector above the columellar region, septa thickened; ZPAL H VII, × 3
3. Distal columellar region: septal projections anastomosing, columella feeble, infaunal tubes penetrate septa and wall (arrow); ZPAL H VII/245, × 3.,
4. Columellar region: septal projections anastomosing, columella strong; ZPAL H VII/247, × 3.
5. Calicular portion in slightly oblique section. *a* General view; wall exfoliated with the exception of the upper part, × 3; *b* a fragment with trabeculae leached at the mid-line resulting in formation of a mid-septal fissure, × 10; ZPAL H VII/241/1.

1—5: loc. 187

Photo G. Podbielska

PLATE 21

Structure of septum in *Flabellum rariseptatum* RONIEWICZ et MORYCOWA, 1985

1. Distal edge with a notch well developed; ZPAL H VII/158, × 2.
2. Longitudinal broken section of corallum: *a* distal edge without a notch, lateral granules in rows, × 1; *b* a fragment displaying vertical inner septal edge smooth in the upper and provided with projections in lower portion, a narrow calicular fossa and a coarse septal granulation that can be observed on the septal surface or as imprints on the surface of the sediment infilling interseptal spaces (arrow), × 4; ZPAL H VII/78.
3. Distal edge slanting, a notch undeveloped; ZPAL H VII/212, × 2.
4. Septum broken along the median septal fissure displaying an internal septal surface with growth lines parallel to the septal edges; ZPAL H VII/84, × 5.
5. Longitudinal broken sections of corallum; the fracture follows the median septal fissure of two opposite septa: *a* general view, growth lines paralleling septal edges well marked, × 1; *b* a fragment showing internal septal surface, i. e. an internal side of the stereomal portion of septum (*st*) appearing on a side of the fissure; growth lines and vertical, delicate traces of leached thin trabeculae (*t*) of the median septal portion are visible, as well as septal lateral granules (lower right corner) preserved as imprints in the sediment infilling the interseptal space, × 17; syntype ZPAL H VII/89.
6. Longitudinal broken section of juvenile corallum 7 mm high: imprints of lateral septal ornamentation and septal growth lines are seen, basal plate is preserved; ZPAL H VII/267, × 8.

1—6: loc. 187

Photo G. Podbielska

PLATE 22

Flabellum rariseptatum Roniewicz et Morycowa, 1985

1, 4. Structure of columella seen in longitudinal broken section; 1 ZPAL H VII/81, × 2, 4 ZPAL H VII/95, × 5.
2, 5, 6. Microstructure of septa in thin sections. *2* Recrystallized septum with zigzag thin mid-line and a large septal granule in cross section; UJ 125P/28, × 75. *5* Fragment of septal mid-line formed of thin trabeculae (*t*) and covered with thick stereomal deposit (*st*) constituting lateral portions of the septal blade, cross section; UJ 125/27, × 100. *6* Cross section presenting septa and wall with accretionary bands of stereomal deposit, the septal mid-line is opaque, the trabeculae are indistinguishable; UJ 125P/27, × 75.
3. Three coralla chaotically buried in siltstone; ZPAL H VII/107, × 1.

1, 3, 4: loc. 187; 2, 5, 6: loc. 182

Photo G. Podbielska

PLATE 23

Juveniles of *Flabellum rariseptatum* Roniewicz et Morycowa, 1985

1. Broken corallum 3 mm high, longitudinal section: basal plate unattached, convex upwards; ZPAL H VII/241, × 10.
2. Broken corallum in longitudinal section: basal plate unattached convex upwards and provided with a sharp edge; ZPAL H VII/248, × 10.
3. Broken corallum in longitudinal section: basal plate attached to a pebble; ZPAL H VII/162/7, × 5.
4. Corallum 8 mm high, side view: S1 and S2 septa originating on the basal plate and S3 septa appearing at 3.5—5.0 mm from the plate (inception places marked with dots); ZPAL H VII/14, × 5.
5. Corallum 4.5 mm high with S3 septa developed at 2.7 mm from the basal plate (inception places marked with dots); ZPAL H VII/241/7, × 5.
6. Broken corallum 7 mm high in longitudinal section: basal plate slightly convex upwards, inner septal edges provided with projections initiating a columella; ZPAL H VII/241/8, × 5.
7. Corallum 8 mm high. *a* Side view: S1 and S2 septa originating at the basal plate and S3 septa at 4.0—4.2 mm from the plate (inception places marked with dots); × 5. *b* Basal view: basal plate ovate, with a sharp edge, fine sediment fills basal plate concavity; ZPAL H VII/195/4, × 15.
8. Basal view of the pedical with basal plate exfoliated (see pl. 24 : 6): S1 and S2 septa originated simultaneously; ZPAL H VII/242/3, × 15.
9. Corallum 8 mm high in side view: S1 and S2 originated on the basal plate and S3 at 4—5 mm from the plate (inception places marked with dots); ZPAL H VII/241/9, × 5.
10. Corallum 11 mm high in side view: S3 incepted at the height between 3 and 4 mm and S4 between 7 and 9.3 mm from the basal plate; ZPAL H VII/241/6, × 5.
11. Basal plate 3 mm in diameter with 12 septa (S1 and S2), attached to the wall of the adult corallum; ZPAL H VII/84 × 16. (Coralla figured in 1, 5, 6, 9 and 10 have been found with four others, an adult one (pl. 20 : 5) including, in a small piece of rock).

1—11: loc. 187

Photo G. Podbielska

PLATE 24

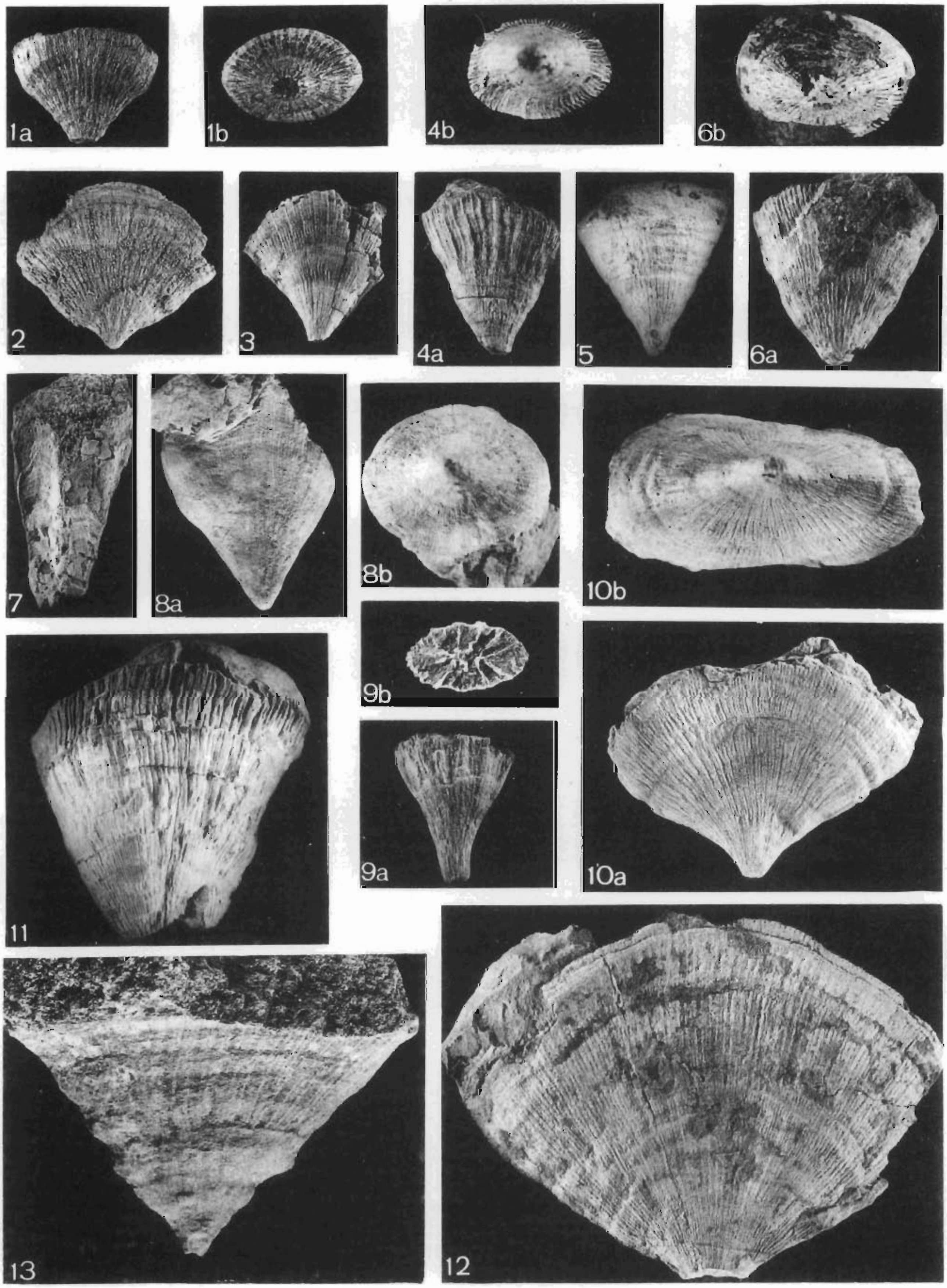
Flabellum rariseptatum Roniewicz et Morycowa, 1985

1. Semilunar attachment scars on the internal wall surface in the interseptal space; ZPAL H VII/133, *a* × 4 and *b* × 16.
2. Attachment scars in the interseptal spaces seen on the external, abraded wall surface; ZPAL H VII/218, × 5.

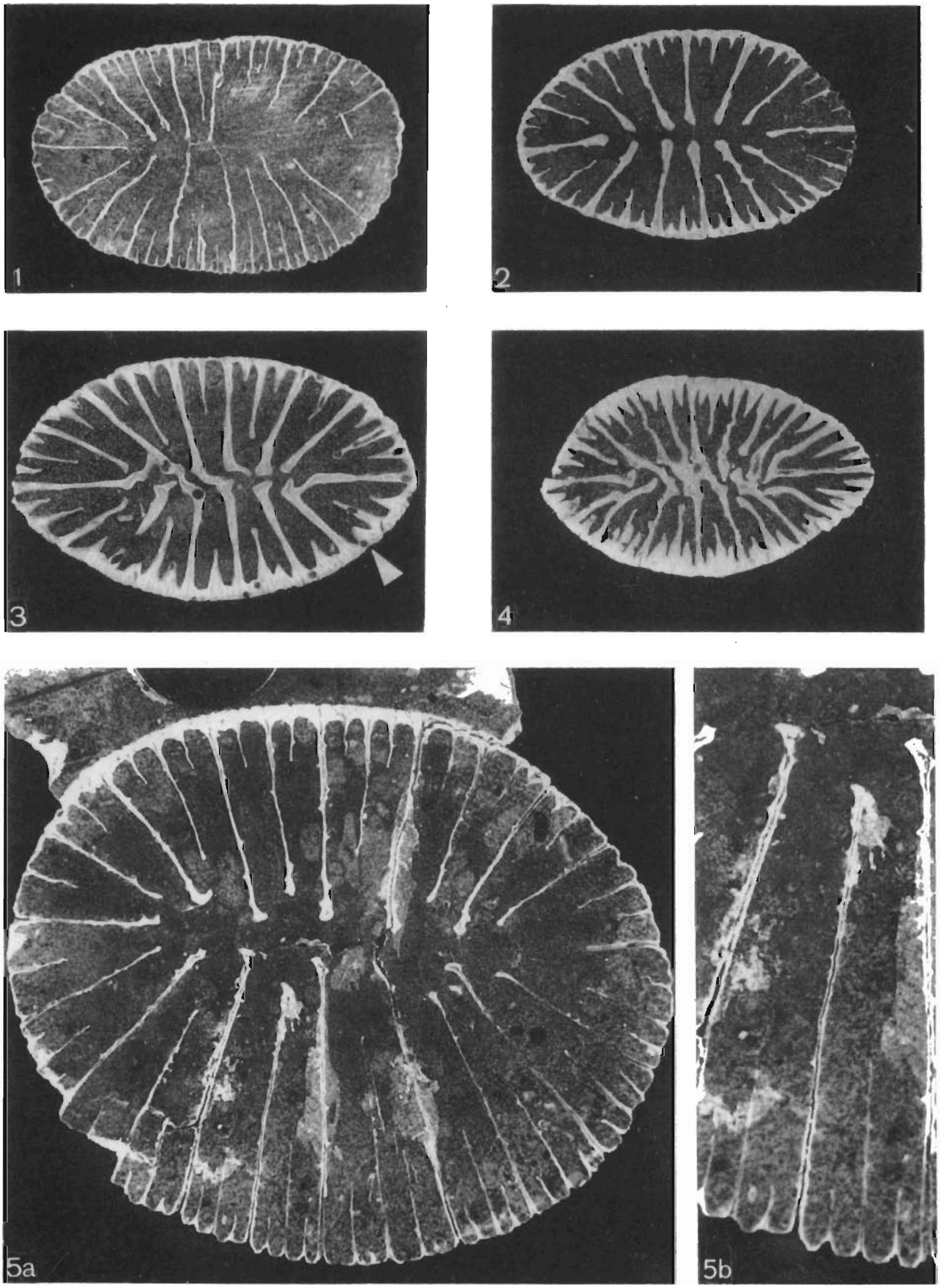
3. Mould of a proximal portion of a juvenile corallum in longitudinal broken section showing obliquely oriented basal plate (*p*), S1 and S2 septa originated from the basal plate, S3 septa appearing at the height of 4 mm and attachment scars (*s*) in the interseptal spaces developed closely to the basal plate; ZPAL H VII/142/6, × 10.
4. Septal side with row of attachment scars (s) situated closely to the wall; ZPAL H VII/78, × 4.5.
5. Juvenile specimen 6.5 mm high (the same in pl. 23 : 6) with well developed projections of the inner septal edge initiating formation of a columella; ZPAL H VII/241/8, × 14.
6. Distal exfoliated portion of a pedicel (see also pl. 23 : 8), basal plate strongly convex upwards; ZPAL H VII/242/3, × 15.
7. Juvenile corallum at the stage of 12 septa (distally equal 4.5 mm) and at the beginning of S3 septa inception (arrow); wall surface and calicular edge preserved, proximal end broken; ZPAL H VII/106/5, × 15.

1–7: loc. 187

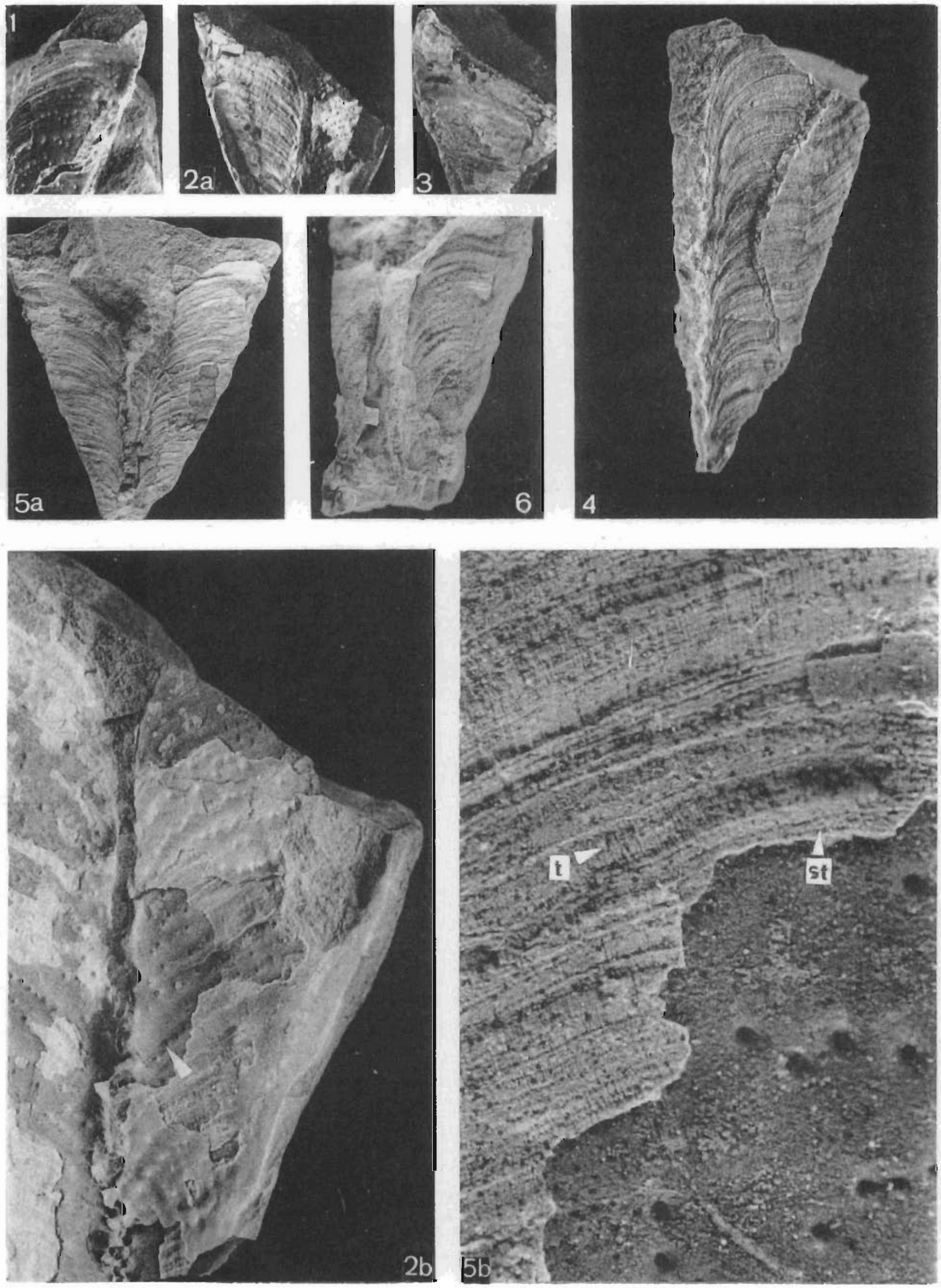
Photo G. Podbielska



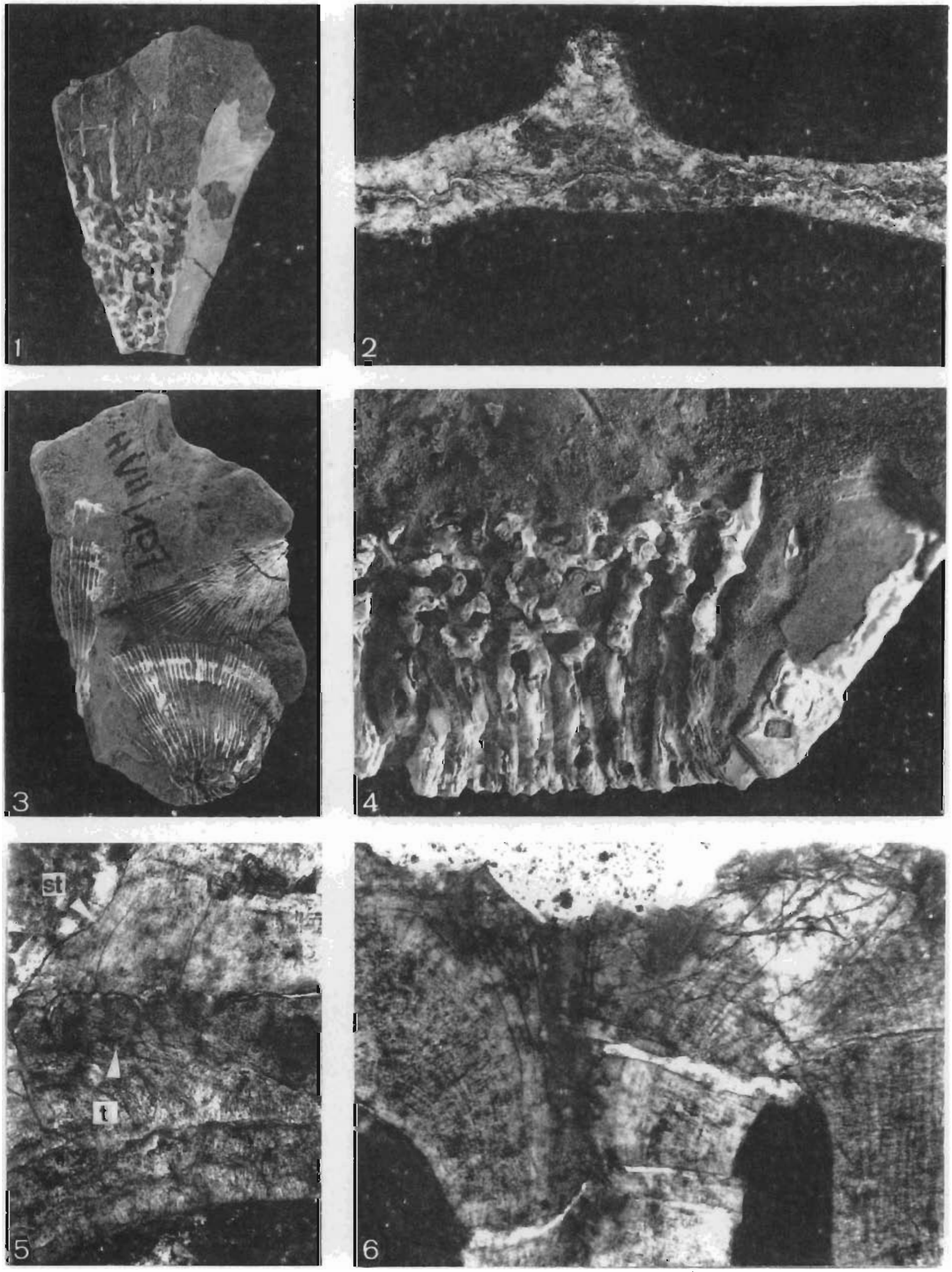
E. RONIEWICZ AND E. MORYCOWA: TERTIARY *Flabellum rariseptatum*



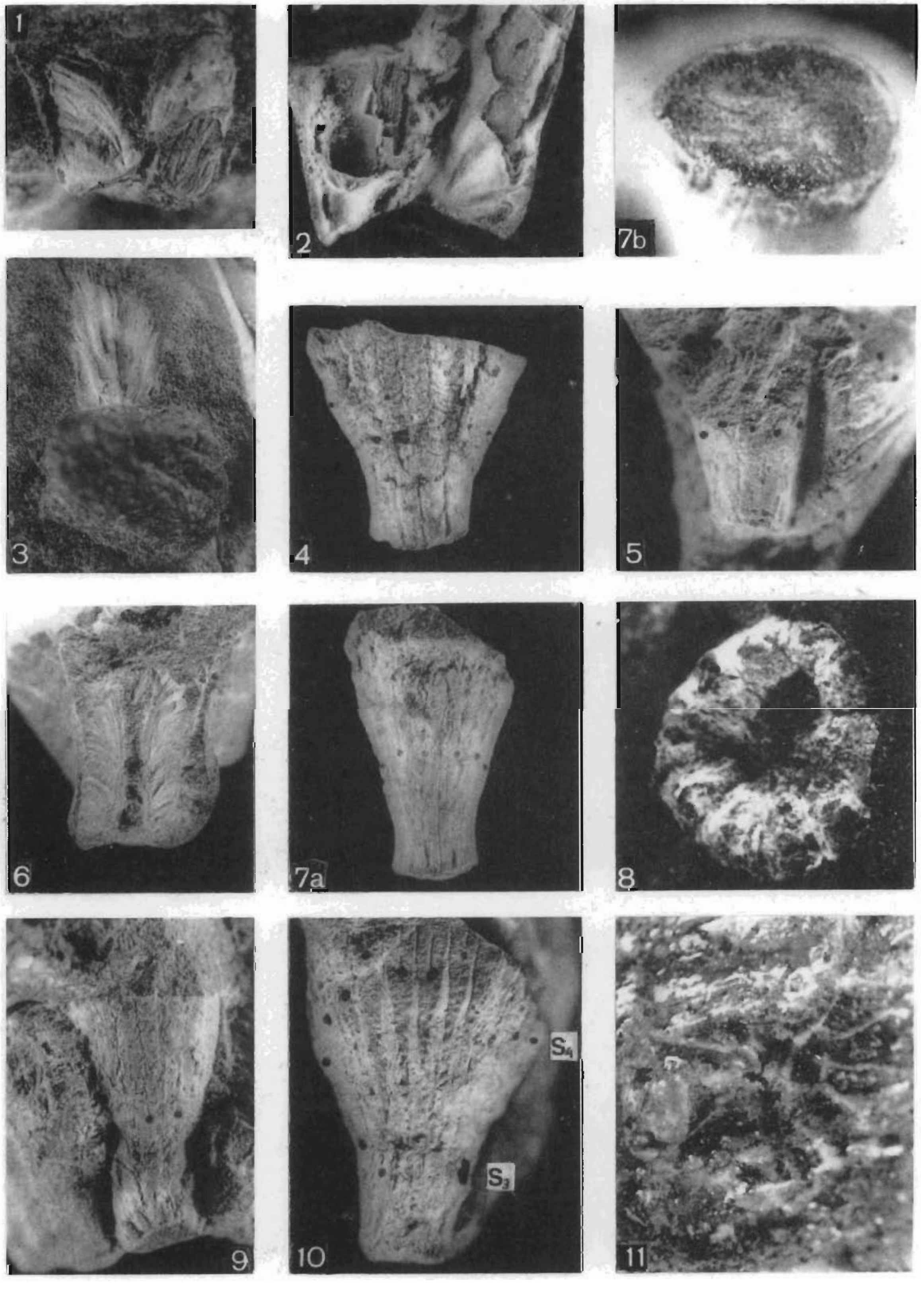
E. Roniewicz and E. Morycowa: Tertiary *Flabellum rariseptatum*



E. Roniewicz and E. Morycowa: Tertiary *Flabellum rariseptatum*



E. RONIEWICZ AND E. MORYCOWA: TERTIARY *Flabellum rariseptatum*



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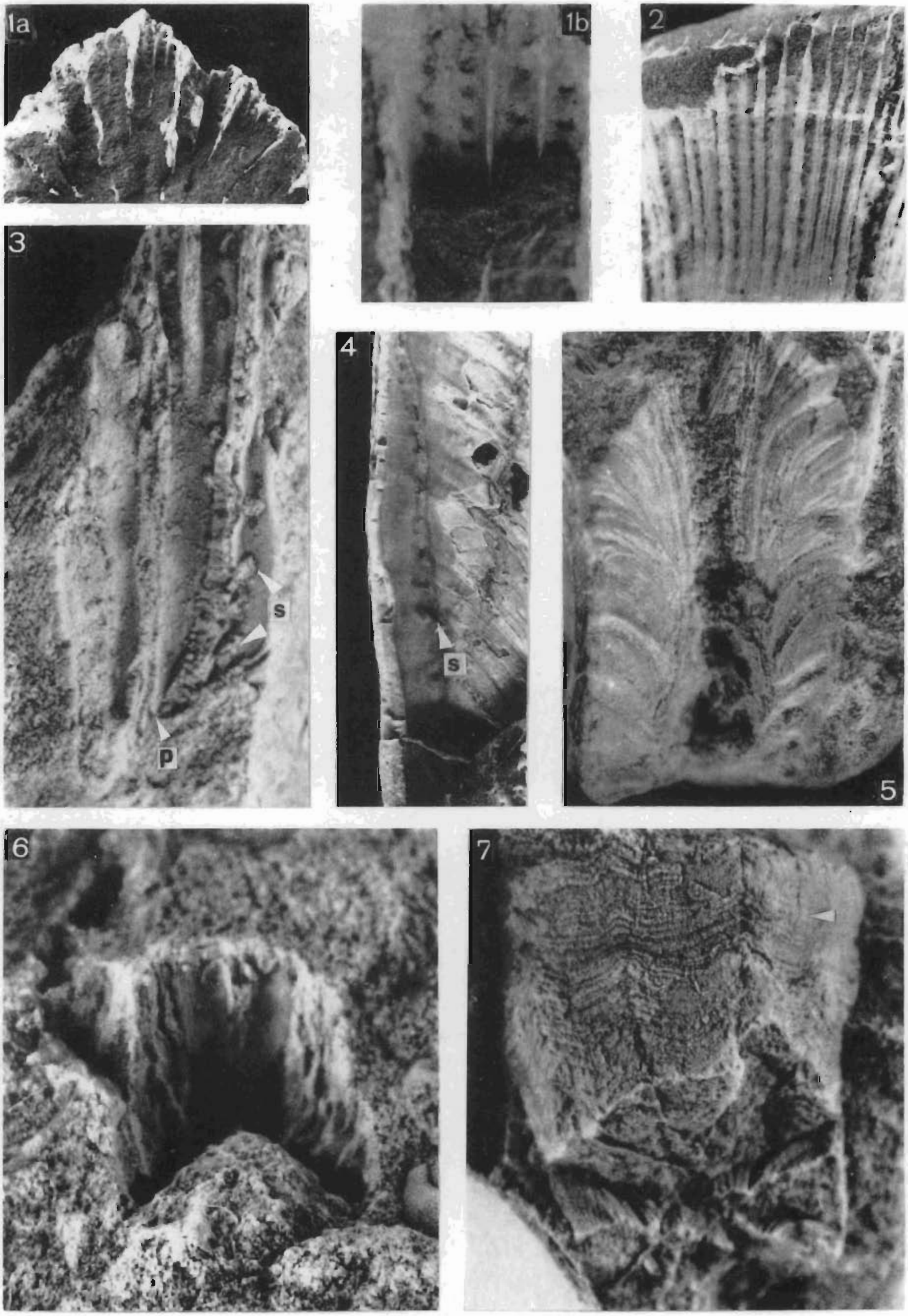

E. Roniewicz and E. Morycowa: Tertiary *Flabellum rariseptatum*