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THE RHIZOCEPHALA OF THE PACIFIC

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The Rhizocephala, parasites of Crustacea of various orders, form a small group of animals, of which the comparatively small number of published records become rather easily accessible in a complete manner, so that in this respect the group lends itself for a survey of the occurrence and the distribution of the species in the Pacific area. The available data are widely scattered in the literature (cf. references at the end of the present paper), most papers dealing with one or a few species, some publications containing data on animals of the group from a distinct geographical area, others again giving the results of an examination of the material of the group preserved in a certain museum. A survey of the available data proves that in certain regions of the Pacific our knowledge concerning the Rhizocephala is fairly well advanced, whilst on the other hand in other parts of the area hardly anything has become known in respect to the parasites of the group.

A list of the species known to occur in the Pacific region follows here, arranged under the various genera. To save space the author's names Boschma (B.), Van Kampen & Boschma (K. B.), and Shiino (Sh.) have been abbreviated as indicated in brackets. Behind each name one or more numbers are added in brackets, these refer to the geographical areas briefly to be indicated as: 1, Japan; 2, China; 3, Philippine Islands; 4, South East Asia; 5, East Indian Archipelago; 6, New Guinea and Torres Strait; 7, North East and East Australia; 8, North America, including Bering Sea; 9, South America; 10, Central Pacific. It is not intended to regard these regions as well defined faunal provinces; for the purposes of the present paper, however, they form regions of a more or less distinct character.

Peltogaster boschmai Reinhard (8), *depressus* Reinhard (8), *latus* van Baal (5, 6), *lineatus* Sh. (1), *ovalis* Krüger (1), *paguri* Rathke (1, 8), *reticulatus* Sh. (1), *rugosus* B. (5), *Peltogaster* spec. (6).

Septosaccus reticulatus K. B. (5, 6), *snelliusi* van Baal (5).

Pterogaster involvulus van Baal (5), *philippinensis* (Kossm.) (3, 5).
Dipterosaccus indicus K. B. (1, 5, 6).
Briarosaccus spec. (9).
Temnascus foresti B. (10).
Gemmosaccus gracilis (Kröyer) (9), *sulcatus* (Lillj.) (1).
Peltogasterella socialis Krüger (1, 8), *subterminalis* Reinhard (8).
Angulosaccus tenuis Reinhard (8).

Sacculina ales Kossm. (3), *anceps* B. (5), *anomala* B. (1), *angulata* K. B. (4, 6), *beauforti* B. (5), *bipunctata* Kossm. (3, 5), *brevispina* K. B. (3), *bursa pastoris* Kossm. (3), *caelata* B. (4), *calappae* K. B. (5), *captiva* Kossm. (3), *carpiliae* Guér.-Gan. (10), *cartieri* Kossm. (3), *cavolinii* Kossm. (3), *comosa* B. (5), *compressa* B. (5), *confragosa* B. (1), *cordata* Sh. (1, 5), *crucifera* Kossm. (3), *curvata* B. (3, 5), *cuspidata* B. (5), *dentata* Kossm. (3), *duracina* B. (7), *echinulata* K. B. (6), *elongata* B. (5), *exarcuata* Kossm. (2, 3), *fabacea* Sh. (1), *flacca* B. (5), *flexuosa* Kossm. (3, 5), *formosa* B. (5), *gibba* B. (2), *glabra* K. B. (5), *gordonae* B. (4), *gracilis* B. (2, 3, 4), *granulosa* B. (6), *gregaria* Ok. & Miy. (1), *hirta* B. (1), *hispida* B. (5), *hystrix* K. B. (5), *imberbis* Sh. (1), *inconstans* B. (10), *irrorata* B. (5), *lata* B. (1), *leopoldi* B. (5), *leptodiae* Guér.-Gan. (4, 5, 6, 10), *leptothrix* B. (3), *margaritifera* Kossm. (3, 5), *micracantha* B. (5), *microthrix* B. (5), *muricata* B. (1), *nigra* Sh. (1), *nodosa* B. (5), *ornatula* B. (1), *papposa* K. B. (5), *pilosa* Kossm. (3, 6), *pilosella* K. B. (1, 5), *pinnotherae* Sh. (1), *pisiformis* Kossm. (3), *pistillata* B. (4), *plana* B. (2), *pomum* Kossm. (3), *pugettiae* Sh. (1), *pulchella* B. (5), *punctata* B. (1, 10), *robusta* B. (5, 6), *rotundata* Miers (1, 5), *rugosa* K. B. (5), *scabra* B. (5), *semistriata* K. B. (6), *senta* B. (1), *setosa* K. B. (5), *sinensis* B. (2), *spectabilis* B. (6), *spinosa* K. B. (1, 5, 6), *striata* B. (5), *sulcata* K. B. (5), *teres* B. (5), *teretiuscula* B. (4), *ternatensis* B. (5), *upogebiae* Sh. (1), *vankampeni* B. (6), *verrucosa* K. B. (5), *weberi* B. (5), *yatsui* B. (1, 5), *Sacculina* spec. (5), *Sacculina* spec. (2), *Sacculina* spec. (7).

Drepanorchis fabacea B. (1), *strigulosa* B. (1).

Heterosaccus californicus B. (8), *distortus* B. (3), *hians* (Kossm.) (2, 5), *papillosus* (B.) (1, 3, 5), *pellucidus* Sh. (1), *ruginosus* B. (1, 4, 5), *setoensis* Sh. (1), *sibogae* B. (5).

Loxothylacus amoenus B. (5), *aristatus* B. (5), *armatus* B. (9), *brachythrix* B. (5), *carinatus* (Kossm.) (2, 3, 5), *corculum* (Kossm.) (3, 5), *desmothrix* B. (5), *echioides* B. (5), *ihlei* B. (6), *murex* B. (5), *musivus* B. (5), *panopaei* (Gissl.) (8), *sclerothrix* B. (5), *setaceus* B. (5), *spinulosus* B. (2), *strandi* B. (2), *tomentosus* Sh. (1), *torridus* B. (5), *variabilis* B. (5, 6), *vepretus* B. (5, 6).

Sesarmaxenos gedehensis Feuerb. (5).

Lernaeodiscus okadai B. (1, 5, 6), *Lernaeodiscus* spec. (10).

Septodiscus flabellum van Baal (5, 6).

Triangulus cornutus (B.) (1, 5, 6), *papilio* (Kossm.) (3, 5).

Clistosaccus paguri Lillj. (8).

Mycetomorpha vancouverensis Potts (8).

Duplorbis smithi Nierstr. & Br. à Br. (5).

Sylon hippolytes M. Sars (8).

Thompsonia affinis Krüger (1), *edwardsi* (Cout.) (6), *globosa* Kossm. (3), *haddoni* (Cout.) (6), *japonica* Häfele (1), *sinensis* Keppen (2), *Thompsonia* spec. (3), *Thompsonia* spec. (10), *Thompsonia* spec. (6), *Thompsonia* spec. (8).

Sphaerothylacus polycarpae Sluiter (5).

The following remarks refer to some of the species of the list.

Peltogaster. In this genus it is often a difficult task to define the characters separating a species from other, previously described ones. Consequently it is not altogether certain that all the described species really deserve this rank.

Peltogaster paguri Rathke was described from off the Norwegian coast, it is a common species on the European side of the Atlantic, and it is known from several localities on the American side. The first specimens reported from the Pacific (Japan) were mentioned by Krüger (1912), without giving distinct arguments for the specific identification; this record therefore remains somewhat uncertain. On the other hand, Reinhard (1944) who identified parasites from two localities in Alaska, examined sectioned specimens and compared these with specimens from the North Atlantic. Because no differences were observed this record appears well founded.

Peltogaster spec. Van Baal (1937) described a specimen from the Aru Islands with obvious abnormalities (an unpaired testis).

Septosaccus indicus K. B. Later a younger specimen was described as *S. plicatus* Boschma (1931a); after renewed examination of the type of *S. indicus* the other species was regarded as a synonym (Boschma, 1931b).

Briarosaccus spec. Weltner (1898) states that a "*Peltogaster* sp." was found to occur on the abdomen of *Lithodes antarcticus* collected in Smyth Channel in Southern Chile. A gigantic Rhizocephalan, nearly 10 cm long, was described as *Briarosaccus callosus* Boschma (1930), a parasite of *Lithodes agassizii* from the Atlantic Ocean. It appears safe to conclude that Weltner's specimen was a *Briarosaccus,* perhaps another species of the genus.

Temnascus foresti. From the Gambier Islands in the Tuamotu Archi-

pelago. Only the type specimen of this peculiar parasite is known (Boschma, 1951d).

Gemmosaccus gracilis, with *G. affinis* as a synonym, the only known Peltogastrid parasite of the South American Pacific coast. The available material is not sufficiently preserved for anatomical research, consequently it cannot lead to a decision in a nomenclatorial question. Among the Rhizocephala of the Copenhagen Zoological Museum there are specimens of "*Ligella gracilis* Kr." and "*Ligella affinis* Kr." from Callao, Peru, and from Valparaiso, Chile, according to the labels the parasites were taken from the hermit crab *Pagurus forceps* M. E. (Boschma, 1931a, 1933a). The parasites belong to the genus *Gemmosaccus* Duboscq (*Chlorogaster* Duboscq, preoccupied). The type of the genus *Gemmosaccus* is *Peltogaster sulcatus* described in 1859 by Lilljeborg. In a paper on Rhizocephala, Kröyer (1855) used the name *Peltogaster gracilis* for specimens from Chile, these undoubtedly were the parasites labelled "*Ligella gracilis* Kr.", which prove to belong to the genus *Gemmosaccus,* the name *Ligella* being a nomen nudum only. The parasites now must be named *Gemmosaccus gracilis* (Kr.), they appear to be entirely similar to *G. sulcatus* (Lillj.), but they cannot be proven to be specifically identical. If this really could be done, the name *P. sulcatus* would become a synonym of the previously published name *P. gracilis.* Kröyer's (1855) note does not contain a real description of *P. gracilis,* but the locality (Valparaiso) is a sufficient indication of the species, the more so because the host, *Pagurus forceps,* is known.

Gemmosaccus sulcatus. Japanese gregarious Peltogastrids were identified by Krüger (1912) as *Peltogaster sulcatus.* When describing the species *Peltogasterella subterminalis,* Reinhard (1944) drew attention to some points of resemblance to *G. sulcatus,* and adds: "This general resemblance of our species to *Gemmosaccus sulcatus* suggests that Krüger's report of finding the latter species on the coast of Japan may be erroneous. Krüger's (1912) account is brief and unsatisfactory, and it may be that the parasites he called *Peltogaster sulcatus* were actually *Peltogasterella* of the species described here." (l.c., p. 55). This proves, at least, that the record by Krüger is far from conclusive.

Peltogasterella socialis. Described from Japan, and St. Olga Bay and Vladivostok in U. S. S. R. (Krüger, 1912), found in Puget Sound by Potts (1915); additional Japanese specimens were mentioned by Hiro (1935); Reinhard (1944) commented upon specimens from Washington, and from Alaska and the Bering Sea.

Angulosaccus tenuis Reinhard (1944) has a superficial likeness to certain species of *Gemmosaccus.* Its anatomical characters warrant generic distinc-

tion. 12 specimens, parasites of one host, are known, from off the coast of Washington.

Sacculina. Kossmann (1872) described a number of species, chiefly from the Philippine Islands, many of which are sufficiently characterized to identify other specimens with one of these. Of some of Kossmann's species, however, the characters are too vague to recognize them as valid species, these have been added to the list because it is not certain that they are synonyms of others. Krüger (1912) gave the name *Sacculina carcini* Thompson to the parasites of 9 species of crabs from Japan, apparently none of these has to bear the name, but the correct identification cannot be given before the material has been examined more accurately.

Sacculina gregaria Okada & Miyashita. A gregarious parasite from fresh water of Japan.

Sacculina levis Boschma (1933c) is a synonym of *S. confragosa* Boschma (1933b).

Sacculina synaptothrix Boschma (1948b) is a synonym of *S. cordata* Shiino (1943). The last cited paper became available to the present author after publication of his 1948b paper.

Sacculina spec. (5). A badly preserved specimen in the material of the Siboga Expedition.

Sacculina spec. (2). The Sacculinid mentioned by Gerstäcker as a parasite of *Melissa fragaria* from China. The characters are unknown so that possibly the species belonged to one of the other genera.

Sacculina spec. (7). Haswell (1888) mentions the occurrence of *Sacculina* on the crabs *Thalamita sima* and *Nectocarcinus integrifrons.* These crabs, both belonging to the Portunidae, are closely allied so that their parasites perhaps were not specifically different. In the above list the record accordingly is regarded as proof of the occurrence of one species.

Heterosaccus californicus is known to infest the crabs *Pugettia producta* (Randall), *Loxorhynchus crispatus* Stimpson, and *Taliepus nuttalli* (Randall) (cf. Boschma, 1950a). MacGinitie & MacGinitie (1949, p. 261) observe: "*Sacculina* parasitizes several species of crabs. The crab most often parasitized by *Sacculina* on our Southwest Coast is *Loxorhynchus grandis,* farther north it is the kelp crab *Pugettia producta,* and in the Puget Sound region it is the rocky tide-pool crab *Lophopanopeus bellus.*" The parasite of *Pugettia producta* is *H. californicus,* the parasite of *Loxorhynchus grandis* has not been studied, but probably it is the same species, whilst the parasite of *Lophopanopeus bellus* has been identified as *Loxothylacus panopaei.*

Of *Heterosaccus hians* (Kossm.) the type locality is Java; Krüger (1912)

gave this name to a *Heterosaccus* from Japan, it is improbable that this identification is correct. Van Kampen & Boschma (1925) gave the name *H. hians* to specimens from the Siboga Expedition, which were later (Boschma, 1931b) described as *H. sibogae.*

Heterosaccus papillosus. Described as *Drepanorchis papillosa* Boschma (1933c); Shiino (1943) placed the species in the appropriate genus.

Loxothylacus panopaei (Gissl.) occurs in the West Indian and in the Caribbean region as a parasite of *Panopeus occidentalis* (Saussure) and allied crabs. Parasites of *Lophopanopeus bellus* (Stimps.) from Nanaimo, British Columbia, are like the Atlantic specimens, so that they were identified as *L. panopaei* (Boschma, 1931a), the differences are too slight to warrant a specific distinction (the hairs of the external cuticle have minute lateral hairs, whilst those of Atlantic specimens are smooth). The host, *L. bellus,* is restricted to the Pacific coast of North America (Alaska, Washington, and California, according to Rathbun, 1930); possibly a more detailed examination might show that the parasites from the two regions have greater differences than at present known. The parasite appears to be much more widely distributed, for Ricketts and Calvin (1948, p. 241) remark: "*Sacculina* afflicts European crabs heavily, but for some reason it is not known on our Atlantic coast. On the California coast usually less than 10 per cent but more than 1 per cent of the kelp crabs examined will be found to be infected. With increase in latitude, rhizocephalans become more abundant; at Sitka even the tide-pool crabs may be afflicted." The last remark gives reason to note Alaska as a locality for *L. panopaei.* As far as concerns the first remark of the quotation, it is true that not a single Sacculinid is known from the North American coast south to Florida.

Sesarmaxenos gedehensis Feuerb. From fresh water in the mountains of Java (Feuerborn, 1931, 1933).

Lernaeodiscus okadai and *Triangulus cornutus* were originally described from Japanese localities (Boschma, 1935); van Baal (1937) published elaborate descriptions of material from the East Indian Archipelago and from the New Guinea region. *Triangulus cornutus* was originally described as *Lernaeodiscus cornutus,* van Baal (l. c.) placed the species in the appropriate genus. The species was referred to as *L. coronatus* by Okada & Okasada (1939).

Lernaeodiscus spec. Edmondson (1946, p. 226) remarks: "The common little crab, *Pachycheles pisoides,* is occasionally found parasitized by a *Sacculina*-like form which is attached to the ventral surface of the abdomen." Because the host belongs to the Anomuran family Porcellanidae, the parasite is obviously a Lernaeodiscid; for the present it must remain uncertain in

which of the three accepted genera that are known to infest Porcellanidae the species must be arranged.

Clistosaccus paguri Lilljeborg. Type locality the North Atlantic region; Reinhard (1944) examined specimens from Alaska and the Bering Sea, specifically not distinct from Atlantic specimens.

Mycetomorpha vancouverensis Potts. Known from the border region of Canada and the U. S. A. only (Potts, 1912; Reinhard & Evans, 1951).

Duplorbis smithi Nierstrasz & Brender à Brandis. The only other species of the genus, *D. calathurae* Smith (1906), came from Greenland.

Sylon hippolytes M. Sars (1870). Occurs on various hosts in North Atlantic waters, no specific differences could be observed, so that provisionally all specimens of *Sylon* are indicated with this name. A *Sacculina* occurring as a parasite of Caridea in the Puget Sound region was mentioned by Harrington & Griffin (1897); Calman (1898) first used the name *Sylon* for the parasites concerned. Potts (1912) studied specimens from the same region.

Thompsonia. The parasites of this genus have been found on crabs, on Caridea, and on a Stomatopod. The diversity of hosts of so many groups of Crustacea makes it difficult to believe that in this genus there are no different species. For lack of definite characters, attempts for specific definitions have generally failed. Some distinct differences have been observed, e. g., in the shape of the parasites (globular or oval), and in their occurring as solitary or gregarious parasites.

Thompsonia edwardsi and *haddoni,* described as *Thylacoplethus edwardsi* and *haddoni* by Coutière (1902a-e) as parasites of *Alpheus edwardsi* from Thursday Island, and of *A. avarus* from Ormont Reef, two localities in the Torres Strait region.

Thompsonia japonica. Type specimens on *Pilumnus* (Häfele, 1911); specimens on *Pagurus* were recorded under the same name (Krüger, 1912). Shiino (1943) examined the specimens on *Squilla oratoria,* first mentioned by Komai (1917); he compared these with specimens on *Actumnus,* and concluded that in all probability they belong to the same species. Now it is difficult to believe that *Thompsonia japonica* occurs as a parasite of hosts belonging to different groups of Crustacea (crabs, a hermit crab, and a Stomatopod), but as long as no specific characters become evident there is no basis for specific distinction.

Thompsonia spec. (3). A solitary specimen on the abdomen of *Alpheus malleodigitus* (Bate) (*Betaeus malleodigitus* Bate) from the Sulu Archipelago (Van Kampen & Boschma, 1925). Hoek (1883, p. 19, notes by J. M(urray?)) mentions two specimens of *Peltogaster* on Caridid shrimps

from Basilan Strait in the Philippine Islands, perhaps these were specifically identical with the parasite described from the Sulu Archipelago. The specimens from off Meangis Island (*Peltogaster* in a tumor near the mouth of an Ophiuroid), mentioned on the cited page, in all probability were no Rhizocephalan parasites.

Thompsonia spec. (10). A gregarious parasite on the first pleopod of *Betaeus malleodigitus* Bate from Levuka, Fiji Islands (Bate, 1888). In the cited publication the parasite is not indicated with a specific name, it probably belongs to *Thompsonia.*

Thompsonia spec. (6). Potts (1915) studied the morphology and the life history of a *Thompsonia* on *Synalpheus brucei,* and gave notes on specimens infesting *Thalamita prymna,* both from Murray Island.

Thompsonia spec. (8). Reinhard (1944) published some notes on specimens from San Juan Archipelago, Washington, not specifically indicated owing to the difficulties in regard to definable characters.

Sphaerothylacus polycarpae Sluiter (1884). A parasite differing from true Rhizocephala by its internal structure and mode of living (in ascidians). Mentioned here for completeness' sake.

When the data of the list are tabulated it becomes at once apparent that as far as concerns the occurrence and distribution of the Rhizocephala some regions of the Pacific area have been much more intensely studied than others (see table). A brief general survey of the various regions follows here.

1. The region of Japan and surrounding seas, including St. Olga Bay and Vladivostok in U. S. S. R., Korea, and the Ryûkyû Islands. These localities are included here because the only species known from St. Olga Bay and Vladivostok, *Peltogasterella socialis* Krüger (1912), occurs in Japan too, whilst, moreover, the specimens recorded from Korea and the Ryûkyû Islands, *Sacculina pinnotherae* and *S. yatsui,* are also represented in Japan (Shiino, 1943). The first Rhizocephalan parasite described from Japan is *Thompsonia japonica* Häfele (1911a, b). At the same time, Krüger (1912) studied a fairly extensive material of Rhizocephala from Japan, he lists *Peltogaster paguri* (identification not altogether certain), *P. sulcatus* (according to Reinhard, 1944, possibly *Peltogasterella subterminalis*), and the new species *P. ovalis*; he further describes *Peltogasterella socialis.* Sacculinidae of 9 different species of crabs were identified by Krüger as *Sacculina carcini* Thomps., these obviously belong to other species. A *Heterosaccus* was mentioned as *H. hians* (Kossmann), probably the specific identification is incorrect. Finally Krüger mentions *Thompsonia japonica* and describes the new species *Th. affinis.* A fairly large number of species were described in various papers by Boschma dealing partly or wholly with Japanese material.

An interesting fresh water species, *Sacculina gregaria,* was described by Okada & Miyashita (1935). Some years afterwards there appeared the important paper by Shiino (1943), dealing with 24 species of Rhizocephala

	Peltogaster	*Septosaccus*	*Pterogaster*	*Dipterosaccus*	*Briarosaccus*	*Temnascus*	*Geminosaccus*	*Peltogasterella*	*Angulosaccus*	*Lernaeodiscus*	*Septodiscus*	*Triangulus*	Total
1. Japan	4	—	—	1	—	—	—	1	—	1	—	1	8
3. Philippines	—	—	1	—	—	—	—	—	—	—	—	1	2
5. East Indies	2	2	2	1	—	—	—	—	—	1	1	1	10
6. New Guinea	2	1	—	1	—	—	—	—	—	1	1	1	7
8. North America	3	—	—	—	—	—	—	2	1	—	—	—	6
9. South America	—	—	—	—	1	—	1	—	—	—	—	—	2
10. Central Pacific	—	—	—	—	—	1	—	—	—	1	—	—	2

	Sacculina	*Drepanorchis*	*Heterosaccus*	*Loxothylacus*	*Sesarmaxenos*	*Clistosaccus*	*Mycetomorpha*	*Duplorbis*	*Sylon*	*Thompsonia*	*Sphaerothylacus*	Total	Total of the two tables
1. Japan	20	2	4	1	—	—	—	—	—	2	—	29	37
2. China	6	—	1	2	—	—	—	—	—	1	—	9	10
3. Philippines	18	—	2	2	—	—	—	—	—	2	—	24	26
4. S. E. Asia	7	—	1	—	—	—	—	—	—	—	—	8	8
5. East Indies	38	—	4	14	1	—	—	1	—	—	1	59	69
6. New Guinea	10	—	—	3	—	—	—	—	—	3	—	16	23
7. East Australia	2	—	—	—	—	—	—	—	—	—	—	2	2
8. North America	—	—	1	1	—	1	1	—	1	1	—	6	12
9. South America	—	—	—	1	—	—	—	—	—	—	—	1	3
10. Central Pacific	4	—	—	—	—	—	—	—	—	1	—	5	7

Number of species of Rhizocephala occurring in the various regions of the Pacific.

from the Japanese region, 12 of which had to be described as new. An interesting peculiarity is the occurrence of *Dipterosaccus indicus* as a common species at Seto, a species previously known from the East Indies and from the New Guinea region. With its 37 species of Rhizocephala the Japanese region is one of the best known of the Pacific area.

2. China, with Formosa and the adjoining regions of the sea. Our knowledge of the Rhizocephala of this region is still altogether fragmentary.

Keppen (1877) described a *Thompsonia* from China as *Th. sinensis*; in later years 6 species of Sacculinidae have become known from a few localities in China (Hongkong, Shanghai), one (*Sacculina plana*) from Formosa (Taiwan), and one (*Loxothylacus strandi,* originally identified as *L. aristatus*) from the Macclesfield Bank at a depth of 75-83 m. To these may be added the Sacculinid of *Melissa fragaria* reported from China by Gerstäcker (1866-1879), it is unknown to which of the genera of the Sacculinidae this specimen belongs. The total number of 10 Rhizocephala for the Chinese region is too small to conclude that our knowledge of the parasites of this group in the large area is satisfactory. Undoubtedly a great number of species occur here which up till now have not been recorded. It is a striking fact that not a single Peltogastrid and not a single Lernaeodiscid have become known from the region.

3. Philippine Islands region, including the Sulu Archipelago. For a long time this region has been the best known of the Pacific area as far as concerns the Rhizocephala. Kossmann (1872) described one *Peltogaster,* 17 *Sacculina,* and one *Thompsonia* (*Th. globosa*) from the Philippines. He was the first to draw attention to the excrescences of the external cuticle of the Sacculinidae as valuable characters for specific distinction, and published important notes on anatomical peculiarities of the various species. Many of Kossmann's species now are classified in other genera, but this does not diminish the fundamental importance of his work. Later researches have brought the total number of Rhizocephala known from the Philippine Islands region up to 26, so that at present it still is one of the best known of the Pacific area.

4. South East Asia (Indo-China, Siam (Thailand), including the Gulf of Siam, and Malay Peninsula, including Singapore Island). Records for Rhizocephala from Indo-China have not been published; preliminary examination of material collected near the Marine Station at Nhatrang showed that at least four different species of Sacculinidae occur here. Among the material from Dr. Th. Mortensen's Expedition to Siam in 1900 there proved to be four different species of the genus *Sacculina,* collected on various islands in the Gulf of Siam. Six species of Sacculinidae have been reported from the Malay Peninsula and Singapore Island. Some of these species occur in the two parts of the region, so that the total number of known species becomes 8. As yet no Peltogastridae or Lernaeodiscidae are known to occur here. It stands to reason that this poor result is due to insufficient knowledge of the region, further research undoubtedly will show that many more species are represented.

5. The East Indian Archipelago. The first Rhizocephalan to become known

from the East Indies (Java) was *Sacculina hians* Kossmann (1872), later to become the type of a separate genus, *Heterosaccus* Smith (1906). Miers (1880) described *Sacculina rotundata* from this region, Zehntner (1894) mentioned an unidentified Sacculinid, Nierstrasz & Brender à Brandis (1923) described *Duplorbis smithi,* a species of a genus previously known from Greenland waters only. Van Kampen & Boschma (1925) reported upon numerous specimens, chiefly from the material of the Siboga Expedition. De Man (1928) mentioned the occurrence of Sacculinidae on three species of crabs from the region. In a number of papers the present author described several new species, including those of the Danish Expedition to the Kei Islands in 1922 (Boschma, 1931a). A peculiar parasite of fresh water crabs was described by Feuerborn (1931, 1933) from the mountains of Java. Important investigations on Peltogastridae and Lernaeodiscidae of the Snellius Expedition were published by van Baal (1937). One interesting species may yet be mentioned, *Loxothylacus variabilis* Boschma (1940), of which the various specimens have male organs showing all the intermediate stages between those of *Sacculina* and the shape commonly occurring in *Loxothylacus.* 69 species of Rhizocephala reported from the region warrant the conclusion that it is among the best known of the Pacific. Our knowledge of the occurrence and the distribution of the Rhizocephala of this region, however, is still far from exhaustive, even not all the material of Sacculinidae collected during the Snellius Expedition in 1929 and 1930 has been sufficiently studied.

6. New Guinea and Torres Strait. The records for Waigeu, Salawati, and Misol, islands in the vicinity of New Guinea, belong here; moreover, the Aru Islands are included in this region, because zoogeographically they form a unit with New Guinea. From the Torres Strait 3 representatives of the genus *Thompsonia* have been reported by Coutière (1902a-e) and Potts (1914, 1915), no other genera are known to occur here. From New Guinea and surrounding islands 20 species of Rhizocephala have been reported. Though the region is fairly well known in comparison to many other parts of the Pacific, further research without doubt will reveal the occurrence of many more species than known at present. Especially the Torres Strait region needs further investigation.

From the group of islands North, East and Southeast of New Guinea, viz., the Admiralty Islands, New Britain, the Solomon Islands, the New Hebrides, New Caledonia, and the Loyalty Islands, not a single Rhizocephalan parasite has become known.

7. The East coast of Australia, including the Great Barrier Reef region. Haswell (1888) mentions the occurrence of a Sacculinid on two species of

crabs near Sydney. It is uncertain whether these belonged to the same or to different species. The description of *Sacculina duracina* Boschma (1933b) is based on specimens from a depth of 25 m off Port Molle, Queensland. These are the only published records for the region. Undoubtedly a number of species of the group occur here which as yet have not been examined. Material from the Sydney Museum sent to the present author for examination up till now has only been cursorily studied, it still needs sectioning, which probably will lead to statements on species new for the region. Collection of additional material leading to further research is badly needed.

8. North America, from the Bering Sea, the Aleutian Islands and Alaska to southern California. Two Sacculinidae are known from this region, *Heterosaccus californicus* from various localities in California, and *Loxothylacus panopaei* from the State of Washington to Sitka in Alaska. From the region of the border of Canada and the United States a *Sylon* is known, provisionally to be identified as *S. hippolytes*. Moreover the peculiar Rhizocephalan *Mycetomorpha vancouverensis* Potts (1912) is known from this region only. Until recently the Peltogastridae of the region were practically unknown, a *Peltogaster* spec. being reported from the coast of Vancouver Island by Boschma (1931a). Of fundamental importance for our knowledge of the Peltogastridae of the region is a paper by Reinhard (1944) dealing with animals of the group from the Bering Sea, Alaska, the Canadian and the United States region of the Pacific. The paper contains data on three species of *Peltogaster* (two new), on two of *Peltogasterella* (one new), and on the new genus and species *Angulosaccus tenuis*, a gregarious parasite with a peculiar course of the male organs, which have their openings anteriorly instead of posteriorly. In Reinhard's paper two species are discussed which previously were known from the North Atlantic region only, viz. *Peltogaster paguri* and *Clistosaccus paguri* (*P. paguri* was mentioned for Japan by Krüger, 1912, but the identification was apparently not based on a study of the anatomy of the specimens). Reinhard examined sectioned specimens of the two above mentioned species, and compared these with material from the North Atlantic. No specific differences could be found, so that the conclusion of occurrence of the two species in the Pacific as well as in the Atlantic appears to be well founded. Finally Reinhard describes the peculiarities of a species of *Thompsonia* from a hermit crab in San Juan Archipelago (Washington); for want of distinctive characters no specific name was given to this parasite. As far as concerns the occurrence of Rhizocephala the region now is fairly well known, perhaps it is the best known of all the regions of the Pacific.

It is probable that future research will lead to some more data on the

occurrence of Rhizocephala from the American coast. As far as known at present, *Loxothylacus panopaei* occurs, as a parasite of *Lophopanopeus bellus,* in the northern part only. A Rhizocephalan parasite of an allied species, *Lophopanopeus diegensis* Rath., was recorded from Southern California by Rathbun (1930, p. 328). Though the parasite has not been examined, the record points to a distribution of *Loxothylacus panopaei* in a wider area.

From the coasts of Mexico and Central America not a single Rhizocephalan parasite has become known.

9. South America. Kröyer (1855) recorded *Peltogaster gracilis,* a species of the present genus *Gemmosaccus,* from Valparaiso in Chile; material in the Copenhagen Museum proved that this species was collected both at Valparaiso and at Callao in Peru. A Peltogastrid reported from southern Chile in all probability was a representative of the genus *Briarosaccus* (Weltner, 1898). For long years these were the only data concerning the occurrence of Rhizocephala along the South American coast; recently the species *Loxothylacus armatus* was described from Talcahuano in Chile (Boschma, 1949e). The few available data indicate that the Pacific region of South America up till now has been altogether insufficiently studied in respect to the occurrence of Rhizocephala.

10. The groups of islands in the Central Pacific. Extremely few are the records of Rhizocephala known to occur in the Central Pacific, they may be briefly summarized as follows. *Sacculina punctata* has been recorded from the island Yap in the Caroline Islands (Boschma, 1953, previously, Boschma, 1931a, identified as *S. flexuosa*). A specimen of *S. carpiliae* Guér.-Gan. is known from Aranuka in the Gilbert Islands (Boschma, 1949a), from the same island a specimen of *S. inconstans* Boschma (1952a) has become known. Two specimens of *S. leptodiae* Guér.-Gan. were found on the reefs near Tomberua Island in the Fiji Islands (Boschma, 1950b). The only species of the family Peltogastridae reported from the Central Pacific is *Temnascus foresti* Boschma (1951d), collected in the Gambier Islands in the Tuamotu Archipelago. According to Edmondson's (1946) notes a Lernaeodiscid, as yet unidentified, has been observed in the Hawaiian Islands. Finally a parasite of a snapping shrimp, regarded as a species of the genus *Thompsonia,* has been reported from the Fiji Islands (Bate, 1888). This brings the total number of Rhizocephala known from the Central Pacific up to seven species, which leads to but one conclusion: collecting and examination of Rhizocephala from this vast region has been almost entirely neglected.

The data accumulated in the present paper show that as far as concerns the occurrence and distribution of the Rhizocephala some regions of the Pacific have been more or less elaborately studied (Japan, Philippine Islands, East

Indies, New Guinea, and North America), from other regions very little is known (China, S. E. Asia, Australia, South America, and Central Pacific). Here there is not a gradual difference in the advance of knowledge in the various regions, for the regions are either well known or badly known. The most striking fact is that in the Central Pacific hardly a start has been made for the study of animals of the group. Further research undoubtedly will yield interesting results of an unexpected character.

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