

Investigations Concerning the Taxonomic Status of the Sea Pen *Ptilosarcus gurneyi* (Cnidaria, Pennatulacea)

Introduction

Ptilosarcus gurneyi (Fig. 1) is found in the northeastern Pacific Ocean usually in a muddy or sand-mud substratum (Verrill, 1922; Deichmann, 1936). The species seems to be limited to a narrow band from about 3-135 m in depth with a latitudinal range from Alaska to southern California.

This sea pen has been described by numerous authors (Gray, 1860; Gabb, 1862; Moroff, 1902). Variations in color, among other features, have led to the assignment of different generic and specific names without clear evidence that different taxa were actually being described. The purpose of this paper is to investigate the validity of the existing taxonomic designations of the shallow water West Coast sea pen.

Sea Pen Nomenclature

The following is a list of taxonomic names which have been used to describe what is apparently a single species. A history of these nomenclatural changes is presented immediately following the list.

Sarcoptilus Gray, 1848.

Sarcoptilus (*Ptilosarcus*) *gurneyi* Gray, 1860.¹

Ptilosarcus Verrill, 1865.

P. gurneyi Verrill, 1865.

P. quadrangularis Moroff, 1902.¹

P. quadrangulare Flora, 1966.

P. guerneyi Deichmann, 1941.

P. verrilli Boone, 1933.

Leioptilus Gray, 1860.

L. guerneyi Flora, 1966.

L. quadrangulare Flora, 1966.

Leioptilum Verrill, 1865.

L. quadrangulare Kükenthal, 1913.

Leioptillum Verrill, 1868.

Lioptilum Kölliker, 1872.

Pennatula Linnaeus, 1758.

P. tenua Gabb, 1862.¹

P. tenuis Gray, 1870.

¹ = actual species description. Other authors and dates are given to show authorship of mis-identifications or of misleading spelling variations.

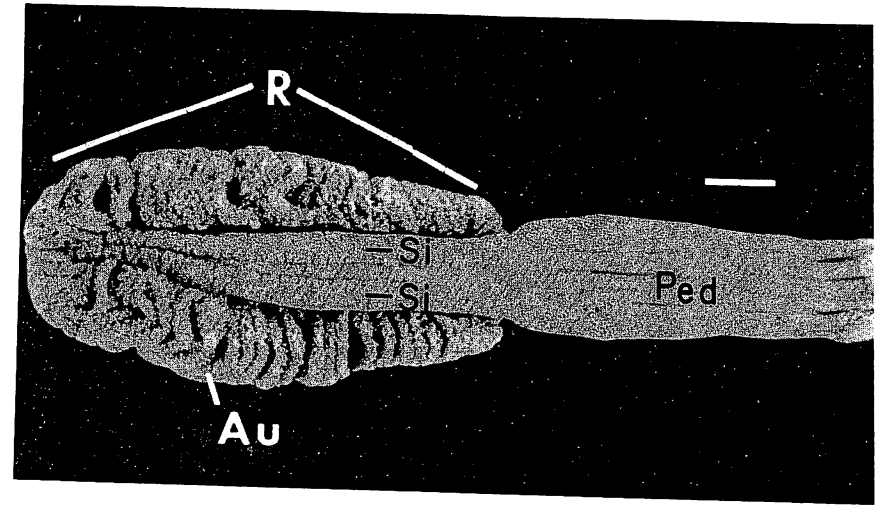


Figure 1. *Ptilosarcus gurneyi* showing peduncle (Ped), rachis (R), numerous autozooids (Au) at edge of leaf plates, and the two siphonozooid (Si) bands. Scale: 2 cm.

Gray (1848) described the genus *Sarcoptilus* which he later (1860) divided into two subgenera, *Sarcoptilus* and *Ptilosarcus*. He named two new species, *Sarcoptilu* (*Ptilosarcus*) *sinuosus* from New Guinea and *Sarcoptilus* (*Ptilosarcus*) *gurneyi* from Monterey Bay, California. He also named a new genus from Japan, *Leioptilus*. This latter animal was previously called *Pennatula fimbriata* Herklots, 1858, but was removed from *Pennatula* by Gray and the new genus established with *Leioptilus fimbriat*. (Herklots, 1858) as the type species.

Subsequent spelling variations of *Leioptilum* (Verrill, 1865), *Leioptillum* (Verrill, 1868), and *Lioptilum* (Kölliker, 1872) were applied to this genus, but the first spelling of *Leioptilus* by Gray (1860) is the correct spelling of this genus (International Code of Zoological Nomenclature, 1964, art. 23).

In 1865 A. E. Verrill described a new species of sea pen he called *Leioptilum undulatum*, giving Gray credit for the generic name but using the neuter ending. Verrill also stated that the subgenera *Ptilosarcus* and *Sarcoptilus* were actually separate genera and listed the Monterey Bay specimen as *Ptilosarcus gurneyi*.

Gabb (1862) described a sea pen from the West Coast off Cape Flattery, Washington as *Pennatula tenua*. Gray (1870) listed Gabb's species as *Pennatula tenuis* and considered it as a complete synonym of *Ptilosarcus gurneyi*. The situation was further confused when Moroff (1902) described *Ptilosarcus quadrangularis* from Monterey Bay, California. He also suggested that *Ptilosarcus* and *Leioptilum* are not distinct enough to be separate genera. Later, Kükenthal (1913) suggested that the name *Leioptilum quadrangulare* be used for the California species and indicated that the name *Ptilosarcus* should be subordinated to the name *Leioptilum*. Conversely, Deichmann (1936) stated that *Leioptilus* is equivalent to *Ptilosarcus* but *Ptilosarcus* is preferred.

More recently, Flora (1966) listed, without discussion, the animal as *Leioptilus*

guerneyi = *Leioptilus quadrangulare* = *Ptilosarcus quadrangulare* = *Ptilosarcus quadrangularis*.

A question of priority, however, exists concerning the generic name *Leioptilus*. This name was published simultaneously by Gray (1860) for the sea pen and by Wallengren (1860) for a European plume moth (Lepidoptera, Pterophoridae) as cited by Neave (1939). However, Wallengren's article was actually published in October of 1859; Gray's article was not published until 1860. This gives Wallengren's genus *Leioptilus* priority, and, therefore, the name cannot be applied to the sea pen as Gray suggested.

Since later authors (Kölliker, 1872; Moroff, 1902; Kükenthal, 1911; Kükenthal and Broch, 1913; Kükenthal, 1915; Hickson, 1916) stated that the sea pen names *Leioptilus* and *Ptilosarcus* are synonyms, it is apparent that *Ptilosarcus* is the earliest valid generic name for the sea pen.

Moth Nomenclature

Zeller (1867) changed the spelling of Wallengren's genus of moth from *Leioptilus* to *Lioptilus*. However, Neave (1939) has indicated that the genus *Lioptilus* was already occupied by 1867, having been used by Cabanis in 1850 to describe a genus of bird. (Cabanis' *Lioptilus* is not to be confused with Blyth's (1847) *Leioptila* (= *Lioptila* Walden, 1875) a different genus of bird.) As a consequence, *Lioptilus* cannot be applied to the moth genus, emphasizing that *Leioptilus* is the correct spelling for the moth genus.

Forbes (1923), Essig (1926), Leonard (1928), and McDunnough (1939) all concurred in transferring the moth species of *Leioptilus* into the genus *Oidaematophorus* Wallengren, 1860, thus freeing *Leioptilus* for use as a generic name. By 1939, then, the use of *Leioptilus* as a genus of moth had been abandoned, making this name available for occupancy. If the sea pen genera *Ptilosarcus* (Gray, 1860) and *Leioptilus* Gray, 1860 are synonyms, then *Ptilosarcus* must be used as the correct generic name up to 1939 because of prior occupancy of *Leioptilus* by the moth. Although the name *Leioptilus* was available after 1939, *Ptilosarcus* must still be used as the correct generic name since *Ptilosarcus* was described prior to the date at which *Leioptilus* became available for occupancy.

Discussion

Gray's removal of *Leioptilus* from *Pennatula* was considered to be incorrect, based on two characters which he used to separate the two genera: (i) the leaf shape and (ii) the position of the siphonozooids. The leaf shape of *Pennatula* varies from a triangular shape to a sickle shape. The leaf shape of Gray's *Leioptilus fimbriata* (Fig. 2) is also sickle shaped. The siphonozooids of *Pennatula* extend from the dorsal tract out between the leaf plates. Gray's *Leioptilus fimbriata* (Fig. 3) has the same characteristic. Based on these characters, Gray's *Leioptilus* cannot be shown to be different from *Pennatula*. Species which were later incorrectly placed in *Leioptilus* clearly belong to *Ptilosarcus*. *Leioptilus fimbriata* should therefore be replaced by *Pennatula fimbriata* as originally described by Herklots (1858), and the remaining species of *Leioptilus* (*L. undulatum* Verrill, 1865) should be moved into *Ptilosarcus* (ICZN, arts. 23, 79).

Gray's genus *Leioptilus* has thus been shown to be invalid based on two different criteria: (i) homonymy (see introduction), and (ii) taxonomic synonymy.

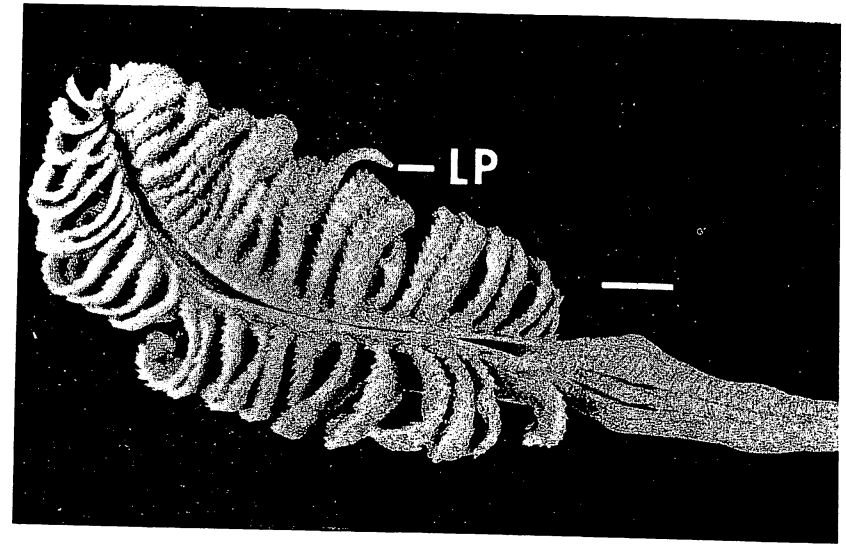


Figure 2. *Pennatula fimbriata* showing sickle-shaped leaf plates (LP) and ventral sulcus length of rachis. Scale: 1 cm.

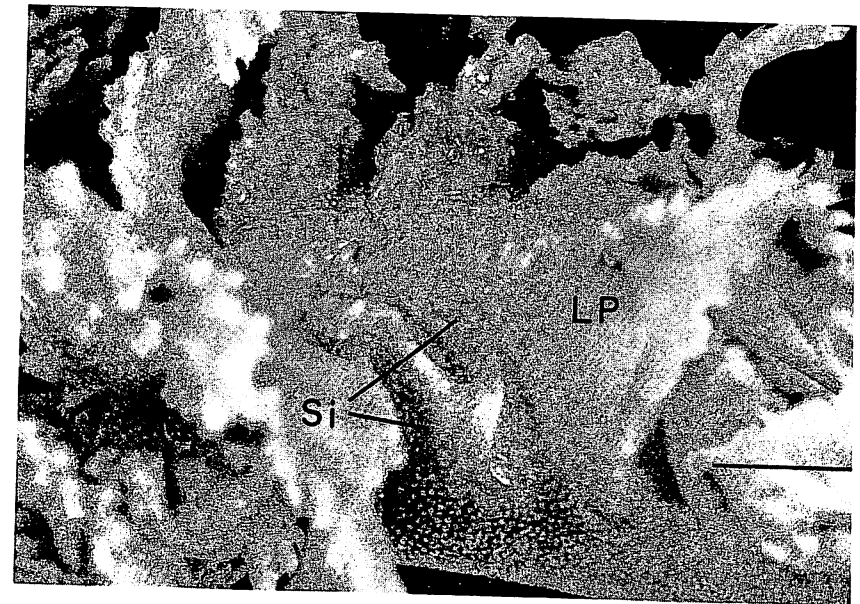


Figure 3. *Pennatula fimbriata* showing siphonozooids (Si) extending between leaf plates (LP). Scale: 0.5 cm.

The genus *Ptilosarcus* is the correct and valid generic name for the West Coast sea an, two species having been described from the Monterey Bay region of California. The first, *Sarcopitilus* (*Ptilosarcus*) *gurneyi* Gray, 1860, is now validly called *Ptilosarcus gurneyi* since Verrill (1865) raised the subgenus *Ptilosarcus* to full generic status. The second is *Ptilosarcus quadrangularis* Moroff, 1902. However, from the description of the two type specimens, no significant taxonomic differences could be found to justify attention of *P. quadrangularis* as a separate species.

Gray (1860) described the new subgenus *Ptilosarcus* as having "Pinnules with a flattened, rather broad edge, spinulose on the margin; cells large, on the flattened edge surrounded with spicula. Stem 1/2 the entire length."

He continued with a description of the new species *Sarcopitilus* (*Ptilosarcus*) *gurneyi*: Orange. Pinnules smooth, very much crowded, closely imbricated, with a rather broad, distinctly spinulose edge. Cells crowded. Stem elongate, thick, half the entire length, much swollen above. California, Monterey. J. H. Gurney, Esq., M.P. Brit. Mus."

Moroff (1902) in describing the new species *Ptilosarcus quadrangularis* stated that the "Plant [sic] is slim, strong, dorsoventrally enclosed; stem comprises almost half of the plant [sic], is very thick, and above the middle has a strong swelling; feather is 2 1/2 times as long as it is wide; 54 leaves in all, semicircular, widely attached, close together, with many small lime needles under the skin; polyp area is 3-4 rowed, covered with strong needles; polyp calyces with two teeth; polyps without lime needles in the entacles; ventral [sic] zooids are of a kind found on low warts; no lateral zooids; axis has four edges, is orange in color; chalk grains appear overall, orange in color."²

Because of the ambiguous descriptions, it was necessary to obtain the type specimen of *P. gurneyi* from the British Museum, and the type specimen of *P. quadrangularis* from the Munich Museum. Upon receipt of the animals from the British Museum, it was discovered that the animal from which the new subgenus and species were erected by Gray (1860) was mislabeled. The collection site, collection date, and the collector corresponded to the original published data, but the animal inside the jar was obviously not the specimen described by Gray. The mislabeled animal was identified as *Pteroeides breviradiatum*, a western Pacific species. The misplaced holotype of *Ptilosarcus gurneyi* was later found under the *Pteroeides breviradiatum* label, and, at the recommendation of the British Museum, both animals were properly relabeled.

The specimens from Munich were labeled as *Ptilosarcus quadrangularis* Moroff, 1902 and consisted of three syntypes in the same container—all three having a single label as "TYPUS." It is interesting to note from Moroff's species description (see above) that the sea pen had 54 leaves. None of the specimens labeled as the types, however, had this many leaf plates. One other specimen from the Munich Museum collection did have 54 leaf plates but it had no collection date or other data on the label other than *Ptilosarcus* sp. Thus none of the three animals labeled as "TYPUS" was actually described by Moroff as the type for the new species.

From the description of *P. quadrangularis* given by Moroff and from the comparison of other specimens of *P. gurneyi* from both museums (Table 1), it is apparent that *Ptilosarcus gurneyi* and *Ptilosarcus quadrangularis* are complete synonyms.

A comparison of the spiculae from the peduncle, siphonozooids, and the autozooids further emphasized that there are no taxonomic differences between the two. Both

² Translation from German by Karin Radtke.

TABLE 1. Comparison of taxonomic characters of *Ptilosarcus gurneyi* and *Ptilosarcus quadrangularis*.

British Museum Specimens	Color	Plate Number	Total length	Ped./Rachis ratio	
<i>Ptilosarcus gurneyi</i> Holotype	orange	43	19.2 cm	9.2/10.0	cm
<i>Leioptilum quadrangularis</i>	red	30	12.5	5.3/7.2	
<i>Leioptilum gurneyi</i>	brown	—	—	10.2/—	
<i>Leioptilum gurneyi</i>	orange	52	25.6	12.9/12.7	
Munich Museum Specimens					
<i>Ptilosarcus quadrangularis</i>					
Typus I	red to orange.	48	23.2	10.2/13.0	
Typus II	red to orange.	33	13.9	7.0/6.9	
Typus III	red to orange.	22	6.5	3.4/3.1	
<i>Ptilosarcus gurneyi</i>	brown	53	15.6	6.5/9.1	
<i>Ptilosarcus</i> sp.	orange	54	25.6	13.4/12.2	
British Museum Specimens					
	Ped./Rachis fraction	Calyx #	Rachis Thickness	Width	
<i>Ptilosarcus gurneyi</i> Holotype	.920	2	2.1 cm	3.7 cm	
<i>Leioptilum quadrangularis</i>	.736	2	2.5	1.4	
<i>Leioptilum gurneyi</i>	—	2	2.7	1.8	
<i>Leioptilum gurneyi</i>	1.015	2	2.6	4.0	
Munich Museum Specimens					
<i>Ptilosarcus quadrangularis</i>					
Typus I	.785	2	3.2	2.5	
Typus II	1.013	2	1.7	1.2	
Typus III	1.095	2	1.0	0.6	
<i>Ptilosarcus gurneyi</i> *	.715	—	1.6	2.2	
<i>Ptilosarcus</i> sp.	1.098	2	2.9	5.0	

* Specimen appears to have been damaged when collected as there are no calyces present.

have rice grained-shaped, flat spiculae in the peduncle (39μ x 78μ) and large tri-flanged spiculae from the autozooids and the siphonozooids (47 - 78μ x 500 - 600μ). Both specimens had two well-formed calyx teeth, produced by the larger spiculae coming together to a pointed projection which arched over the autozooids. The only apparent distinction between the two specimens was that of color. All of the animals labeled *Ptilosarcus quadrangularis* TYPUS were reddish in color. This red color, however, does not seem to be a stable enough character on which to base species differences, as it is not always found uniformly throughout a colony. The edges of the leaves may be red without the peduncle being red, or the entire colony may be red. I have observed some colonies off the Oregon coast with partially red leaves, although the peduncle and the majority of the leaves were orange. It is not known whether this red coloration is seasonal, but it can be highly variable.

The similarity of anatomy, spicule shapes and arrangements, and the variability of color suggests that *Ptilosarcus gurneyi* and *Ptilosarcus quadrangularis* are complete synonyms. Since *P. gurneyi* was described in 1860 and *P. quadrangularis* in 1902, the name *P. gurneyi* has priority. The syntypes of *P. quadrangularis* should thus be considered as *P. gurneyi* topotypes. Therefore, based on earlier findings, it is apparent that *Ptilosarcus* and *Leioptilum* are complete synonyms, with *Ptilosarcus* the preferred name. It is also apparent that *Ptilosarcus gurneyi* (Gray, 1860) and *Ptilosarcus quad-*

rangularis Moroff, 1902 are complete synonyms. It is suggested that all of the species formerly allied with *Leioptilus* (except *L. fimbriata* which is a *Pennatula*) be now allied with *Ptilosarcus* and that *Ptilosarcus gurneyi* be used instead of *Ptilosarcus quadrangularis*.

A complete synonymy of the valid species of *Ptilosarcus* is quite complicated although there are apparently only three species: *P. gurneyi*, *P. sinuosus*, and *P. undulatus* (the species name here being a respelling of Verrill's *Leioptilum undulatum* to agree in gender with *Ptilosarcus*). A detailed history of the names applied to this genus and a review of its synonymy are presented in Appendix A. A taxonomic key to the genera of the Pennatulidae, including *Ptilosarcus*, is presented in Appendix B.

Acknowledgments

I wish to express my gratitude to Dr. P. F. S. Cornelius of the British Museum, to Dr. H. Fechter of the Munich Museum, and to Dr. K. Ruetzler of the National Museum of Natural History (Smithsonian Institution) for allowing me to study their priceless specimens, many of which are over 100 years old. I also wish to thank Dr. J. E. Morris and Dr. C. J. Bayne for providing many helpful suggestions in the preparation of this manuscript.

Appendix A

The following is an historical account of the different names applied to this genus (Appendix A Table 1). Appendix A Table 2 gives a synonymy of the different genera and species involved.

It is certain that *Pennatula tenua*, *Pennatula tenuis*, *Ptilosarcus quadrangularis*, and *Ptilosarcus verrilli* (Boone, not *P. verrilli* of Pfeffer) are junior synonyms of *Ptilosarcus gurneyi*. Similarly, *Leioptilus fimbriata*, *Leioptilus fimbriatus*, *Ptilosarcus grayi*, *Ptilosarcus brevicaulis*, *Pennatula sulcata*, and possibly *Ptilosarcus sinuosus* are junior synonyms of *Pennatula fimbriata*.

Ptilosarcus gurneyi (= *P. guernei*) (Boone, 1933, not *P. gurneyi* of Gray), *Leioptilum solidum*, *Ptilosarcus verrilli* (not *P. verrilli* of Boone), and *Ptilosarcus sinuosus* (not *P. sinuosus* of Gray) are all junior synonyms of *Ptilosarcus undulatus* (emend.).

Thus there seem to be three main areas of distribution of the genus *Ptilosarcus*: from Alaska to southern California (*P. gurneyi*), from the Gulf of California to Peru (*P. undulatus*), and from Australia and New Zealand (*P. sinuosus*, if this is different from *Pennatula fimbriata*).

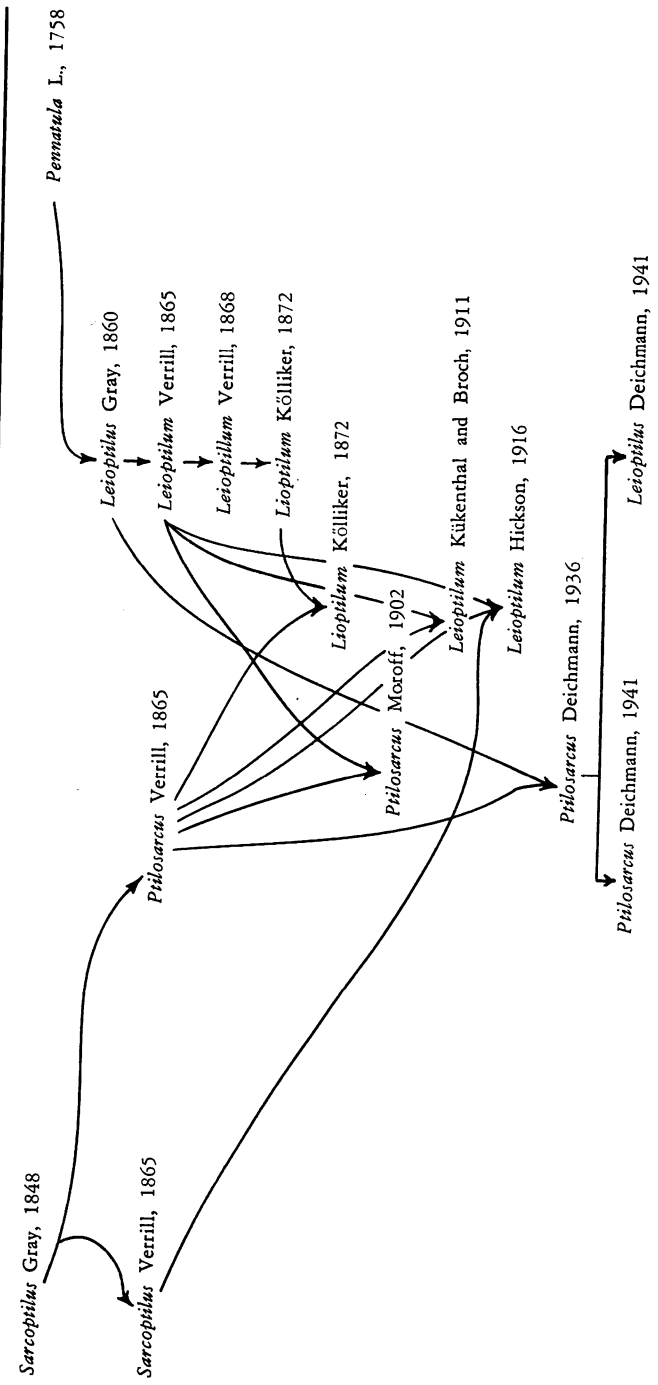
Appendix B

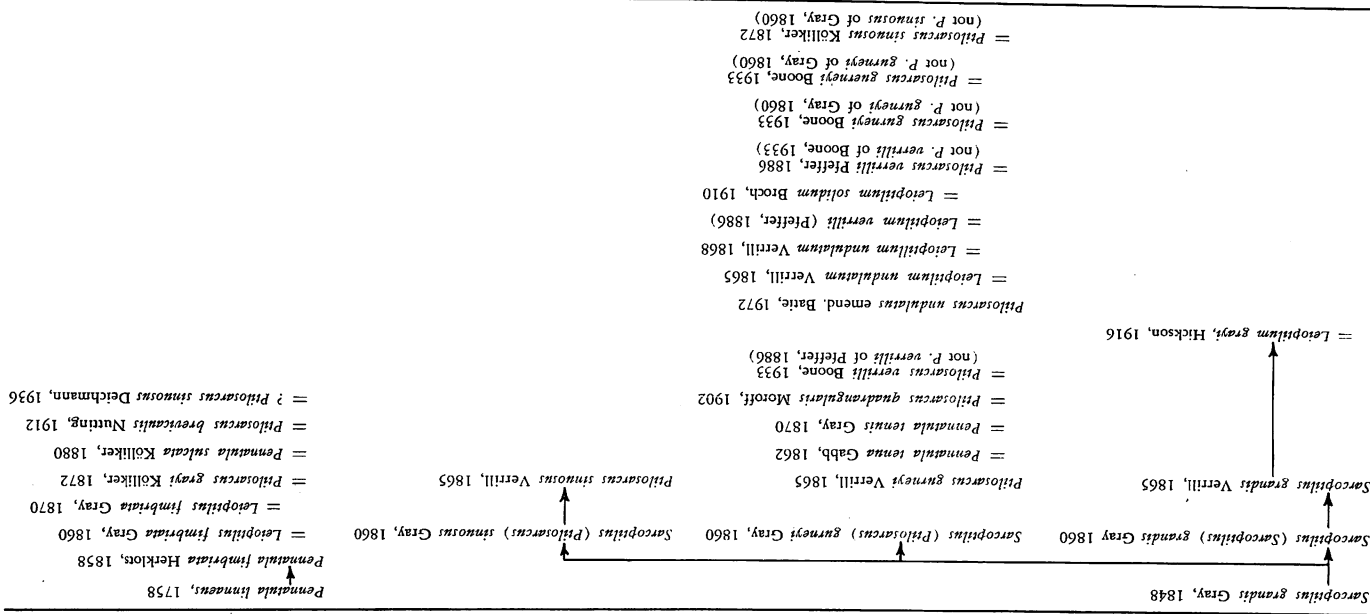
The following is a suggested key to the genera of Pennatulidae accompanied by a key to the species of *Ptilosarcus* found on the West Coast of the Americas:

(adapted from Hickson, 1916 and Deichmann, 1936)

- 1a. With large (300-600 μ) tri-flanged spicules in the leaves. May be limited to edge or cover most of leaf surface. No spicules in tentacles of autozooids. 2

APPENDIX A TABLE 1. Synonymies of *Sarcophilus*, *Ptilosarcus*, and *Leioptilus*. Arrows point from genera under consideration to combined genus with author and date following emended designation.





- 2a. Leaves triangular, fan-shaped or sickle-shaped with long, prominent calyx teeth. Siphonozooids never on leaves, but may extend between leaves. *Pennatula*
- 2b. Leaves kidney-shaped, calyx teeth short and broad. Siphonozooids never extend between leaves but form two bands down dorsal tract of rachis, may be single or in clumps. *Philosarcus* 3
- 3a. With two distinct calyx teeth. Orange to red in color. Siphonozooids not clumped. *P. gurneyi*
- 3b. With one distinct calyx tooth. Siphonozooids and dorsal tract red. Siphonozooids clumped. Calyx tooth yellow tipped. *P. undulatus*
- 1b. With large tri-flanged spicules forming fan-shaped support at base of leaves. Small (30 μ) flat spicules in the calices, rachis, and tentacles. *Acanthopopilum*
- 1c. With small (50 μ) flat spicules in the leaves. *Scytalium*

Literature Cited

Deichmann, E. 1936. Notes on Pennatulacea and Holothuroidea collected by the first and second Bingham Oceanographic expeditions 1925-1926. Bull. Bingham Oceanogr. Coll., New Haven 5(3): 1-11.

Essig, E. O. 1926. Insects of Western North America. New York, Macmillan, 714 p.

Flora, C. J., and E. Fairbanks. 1966. The Sound and the Sea. Bellingham, Wash., Pioneer, 455 p.

Forbes, W. T. M. 1923. The Lepidoptera of New York and neighboring states. Cornell Univ. Agr. Exp. Sta., Ithaca, New York, memoir 68. 647 p.

Gabb, W. M. 1862. Description of two new Pennatulidae from the West Coast of the United States. Proc. Calif. Acad. Nat. Sci. 2: 166.

Gray, J. E. 1848. Revision of the family Pennatulidae, with some descriptions of some new species in the British Museum. Ann. Mag. Nat. Hist. ser. 3(5): 20-25.

1860. Description of *Sarcophilus*, a new Pennatulidae, from the West Coast of the United States. Proc. Calif. Acad. Nat. Sci. 2: 166.

1870. Catalogue of Sea-Pens or Pennatulariidae [sic] in the Collection of the British Museum. London, 40 p.

Hickson, S. J. 1916. The Pennatulacea of the Siboga expedition. Leyden, Siboga expedite 14: 1-256.

1930. Some alcyonarians of the eastern Pacific Ocean. Proc. Zool. Soc. Lond. 1: 209-227.

Leonard, M. D. 1928. A List of Insects of New York with a List of the Spiders and Certain Other Allied Groups. Cornell Univ. Agr. Exp. Sta., Ithaca, New York, memoir 101. 585 p.

Kölliker, A. 1869. Anatomisch-systematische Beschreibung der alcyonarien. Erste Abtheilung. Die Pennatuliden. Abhandl. Senck. Naturf. Gesells. 7: 1-148.

1872. Anatomisch-systematische Beschreibung der alcyonarien. Erste Abtheilung. Die Pennatuliden. Abhandl. Senck. Naturf. Gesells. 8: 1-255.

Kükenthal, W. 1913. Über die alcyonarienfauna Californiens und ihre tierogeographischen beziehungen. Zool. Jahr. Abth. Syst., Oekol., und Geog. 35: 219-269.

1911. Pennatulacea. Wissenschaftlichen Ergebnisse der Deutschen Tiefsee-expedition auf der Dampfer "Valdivia" 1898-1899. Jena. Fischer. 13(1): 113-576.

McDunnough, J. 1939. Checklist of the Lepidoptera of Canada and the United States. Part II. Microlepidoptera. Memoirs Southern Calif. Acad. Sci., Los Angeles, Calif. 2(1): 1-171.

Moroff, T. 1902. Studien über Octocoralien. Zool. Jahr. Abth. Syst., Geog., und Biol. 17: 363-410.

Neave, S. A. 1939. Nomenclator Zoologicus. London, pub. by Zool. Soc. Lond., vol. 2, 1025 p. and vol. 3, 1065 p.

Nutting, C. C. 1909. Alcyonaria of the California coast. Proc. U.S. Nat. Mus. 35: 681-727.

Stoll, N. R., R. P. Dollfus, J. Forest, N. D. Riley, C. W. Sabrosky, C. W. Wright, R. V. Méville (ed. committee). 1964. International Code of Zoological Nomenclature Adopted by the XV International Congress of Zoology. London. 176 p.

- Verrill, A. E. 1865. Synopsis of the polyps and corals of the North Pacific exploring expedition, under Commodore C. Ringgold and Captain John Rodgers, U.S.N., from 1853 to 1856, etc. Proc. Essex Inst. 4(2,3): 181-196.
- _____. 1868. Review of the corals and polyps of the West Coast of North America. Trans. Connecticut Acad. Arts Sci. 1(2): 377-422.
- _____. 1922. The Alcyonaria of the Canadian Arctic expedition, 1913-1918, with a revision of some other Canadian genera and species. Rep. Can. Arctic Exped., Ottawa 8: 1-87.
- Wallengren, H. D. J. 1859. Skandnaviens fjadermott. Svenska Vet. Akad. Stockholm. Handlinger. News series 3(7): 1-25.
- Zeller, P. C. 1867. Über die Europäischen setina-arten. Zweiter Artikel. "Skandnaviens fjadermott (Alucita, L.)." Stettiner Entom. Zeit.: 321-339.

Received January 27, 1972.

Accepted for publication May 28, 1972.

L. W. Gibson

and

I. O. Buss

Department of Zoology
Washington State University
Pullman, Washington

Reactions of Canada Geese to Reservoir Impoundment on the Snake River in Washington

A difficult aspect of river-development evaluation is the effect of dams upon wildlife. Currently a vast network of moderately sized dams is being constructed in the Pacific Northwest. Many of these dams, such as those completed and being completed on the Snake River in southeast Washington, create profound changes in the ecology of the entire region. Unfortunately, the need for pre- and post-impoundment research on such areas is usually realized too late. Vast changes in ecosystems occur without meaningful studies being conducted.

This report is the latest of a continuous series of waterfowl studies, primarily concerning the great basin Canada goose *Brania canadensis moffitti*, conducted prior to, during, and after completion of a series of dams on the Snake River. Buss and Wing (1966) summarized pre-impoundment observations on nesting Canada geese and wintering mallards for the period 1954-1965. Culbertson *et al.* (1971) studied the same area from February 1966 through May 1968, reporting further information on nesting and behavior of Canada geese prior to completion of dam construction. Field work for the present study was conducted from August 1968 to August 1969 and from February 1970 to June 1970 while five remaining islands that had long been used for successful breeding were inundated.

The three objectives of this study are: (1) to evaluate ecological changes and their effects on Canada goose nesting on the Snake River between Almota and Central Ferry, Washington, as dam construction inundated important breeding sites, (2) to study various aspects of goose behavior based partly on marked geese, and (3) to study the use of artificial nesting structures under pre- and post-impoundment conditions.

The Study Area

The study area, which extended from near Clarkston at the Washington-Idaho line westward about 47 miles to Lower Monumental Dam, was divided into four units. Unit A (Fig. 1) extended from Wawawai to near Central Ferry bridge, a distance of approximately 16 miles. Nesting studies have been conducted in this unit since 1954. The five remaining islands in this stretch of the river were inundated in February 1970.

Unit B (Fig. 1) extended 14 miles downstream from Central Ferry bridge to Little Goose Dam. Because geese tended to concentrate in Unit B, this stretch of river was utilized in June and July 1969 for capturing and marking geese. In the spring of 1970 brood behavior was observed in this unit.

Unit C (Fig. 2) extended from Lower Monumental Dam 15 miles upstream to