Mollusks of the Genus *Antiplanes* (Gastropoda: Turridae) of the Northwestern Pacific Ocean

Yuri I. Kantor
Alexander V. Sysoev
A. N. Severtzov Institute of Animal
Evolutionary Morphology and
Ecology of the
U.S.S.R. Academy of Sciences
Lenin Avenue, 33
Moscow 117071, U.S.S.R.

ABSTRACT

Mollusks of the genus *Antiplanes* are represented in the fauna of the northwestern Pacific Ocean by 11 Recent species and one subspecies. Only *Antiplanes vinosa* (Dall) is sinistral; the remaining members of the genus are dextrally coiled. The new name *Antiplanes gabbi* is proposed for *Pleurotoma perversa* Gabb, 1865, the type species of *Antiplanes* and a junior homonym of *Pleurotoma perversa* Philippi, 1847. Six species: *Antiplanes abyssalis*, *A. dendritoplicata*, *A. obliquiplicata*, *A. kurilensis*, *A. spirinae*, and *A. habei* are described as new, as is the subspecies *A. motojimai aquilonalis*. The paucity of diagnostic features together with the high degree of intraspecific and ontogenetic variability in shell characters requires the use of statistical analyses for delineation of species. Three groups of species can be distinguished on the basis of shell sculpture and the rates of growth of radular teeth. *Antiplanes* does not occur in the Gulf of Alaska. Thus, there are no species in common between the Asian (including Bering Sea) and the western American (south of the Gulf of Alaska) faunas.

Key words: *Antiplanes*, Turridae, northwestern Pacific; sublittoral, bathyal, radular growth.

INTRODUCTION

Gastropods of the genus *Antiplanes* are among the largest and most abundant representatives of the family Turridae in the sublittoral and bathyal zones of the northern Pacific Ocean. Although many Recent and fossil species have been described, the validity of many of these taxa is questionable. The present revision of this genus is limited to the fauna of the northwestern Pacific Ocean from northern Japan to the Bering Sea, and is based on the considerable material from this region that was available to us.

MATERIALS AND METHODS

This study was based primarily on the collections of the P. Shirshov Institute of Oceanology of the U.S.S.R. Academy of Sciences (Moscow), the Zoological Museum of the Moscow State University, and the Zoological Institute of the U.S.S.R. Academy of Sciences (Leningrad). These samples, containing about 280 lots and over 900 specimens, were collected in the northwestern Pacific over a period of 90 years. Comparative material from British Columbia was kindly provided by Dr. R. Shimek (Monroe, Washington). The syntypes of *Antiplanes beringi* (Aurivillius) were made available by Dr. A. Warén (Naturhistoriska Riksmuseet, Stockholm). Photographs of the types of W. H. Dall's, E. A. Smith's and T. Habe's taxa were provided by Dr. J. H. McLean (Los Angeles County Museum of Natural History), Mrs. A. Thompson (British Museum (Natural History)) and Dr. A. Matsukuma (National Science Museum, Tokyo), respectively.

When studying shell variability we counted the number of spiral cords on the body whorl. Since the number and degree of cord development on the anal fasciole were quite variable, only cords below the fasciole were counted. In some cases the relative height of the body whorl was an important taxonomic character. In a few cases in which the upper whorls were lost, ratios of the body whorl height to the height of the last three whorls were used. Ratios of the length of the marginal teeth of the radula to shell height were calculated using the mean length of at least ten marginal teeth, measured with an ocular micrometer calibrated to 0.001 mm.

The following abbreviations for scientific research institutes are used:

BM(NH)—British Museum (Natural History), London
CAS—California Academy of Sciences, San Francisco
NRS—Naturhistoriska Riksmuseet, Stockholm
NSMT—National Science Museum, Tokyo
SBMNH—Santa Barbara Museum of Natural History
SDNHM—San Diego Natural History Museum
UCMP—Museum of Paleontology, University of California, Berkeley
USNM—National Museum of Natural History, Smithsonian Institution, Washington, D.C.

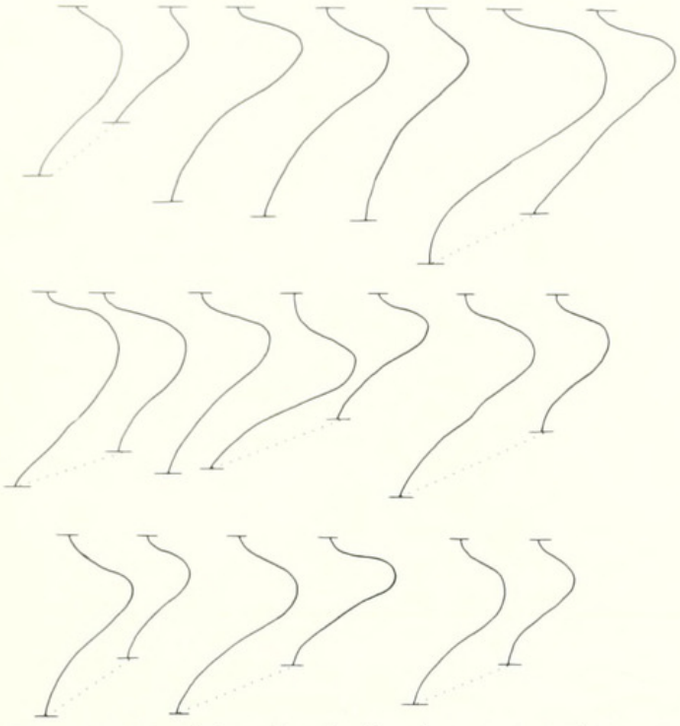

Figure 1. Variability of anal sulcus form in *Antiplanes sanctiioannis* (Smith, 1875). Growth lines along different whorls of the same specimen are connected by dotted lines.

ZIN—Zoological Institute of the U.S.S.R. Academy of Sciences, Leningrad
ZM—Zoological Museum of the Moscow State University

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HISTORICAL REVIEW OF THE GENUS *ANTIPLANES*

The first species presently referred to *Antiplanes* to be described was *Pleurotoma perversa* Gabb, 1865. Dall (1902) proposed the genus *Antiplanes* and described 17 Recent and fossil species from American and Asian waters (Dall, 1874, 1902, 1919, 1925). Bartsch (1944a,b) described three additional American species and isolated the dextral species of *Antiplanes* as a separate genus *Rectiplanes*. Bartsch began a revision of these groups, but this was never completed or published. Three Japanese species were later described by Habe (1958) who also established the subgenus *Rectisulcus* to include those dextral species with well-developed spiral sculpture.

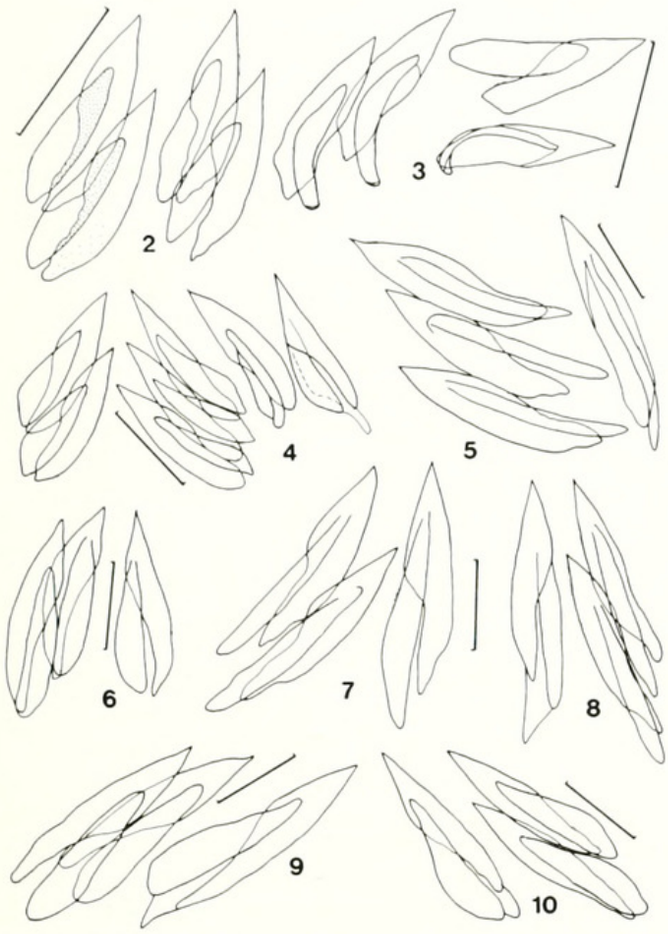
Antiplanes differs from most other members of the family Turridae in containing sinistral forms. The taxonomic status of these sinistral forms has been variously interpreted by recent workers. Based on the study of extensive collections of fossils and Recent specimens from California, Grant and Gale (1931) concluded that the direction of shell coiling was subject to intraspecific variability and synonymized almost all species known at that time with *A. perversa*. This view was shared by Golikov and Gulbin (1977) and by Golikov and Scarlato (1985). Bartsch (194a,b), however, considered sinistrality to be of generic significance.

It was shown in recent malacological literature that most sinistral forms, including those of Turridae, are separate species (Tippett, 1983; Kantor, 1990). However, sinistral individuals and even isolated sinistral populations lacking taxonomic status have been reported (e.g., the sinistral population of *Conus mediterraneus*, see Donati *et. al*, 1984). Analysis of the available material showed that sinistral *Antiplanes* from the northwestern Pacific belong to a single separate species. We have not found any examples of sinistral individuals or populations within normally dextral species of *Antiplanes*.

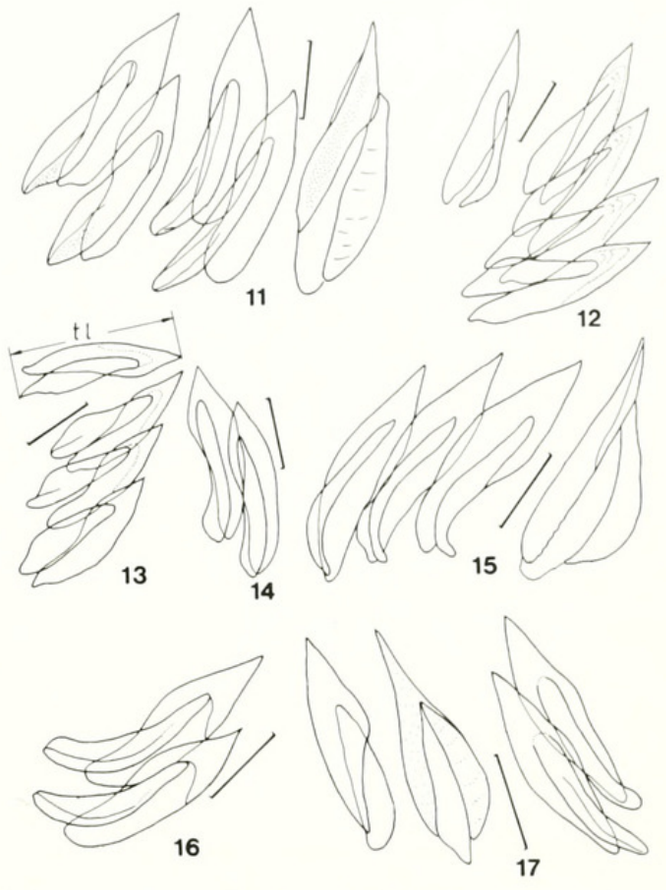
SPECIES VARIABILITY AND CRITERIA FOR SPECIES DIAGNOSES

In our revision of this genus, we encountered an unusually high degree of variability in many conchological features, along with a general paucity of shell diagnostic characters. Thus, characters of shell form and proportions of its parts appeared to be taxonomically insignificant in most cases. Hickman (1976) documented the taxonomic importance of anal sinus shape in Turridae. Our analysis of intraspecific and ontogenetic variation of this feature in nearly 100 individuals of *A. sanctiioannis* as well as in other species showed a very high degree of variability overlapping between species (figure 1).

Although we considered a great many potential conchological characters, the most taxonomically significant feature was determined to be the number of spiral ribs below the anal fasciole. Based on this character, two large groups of species can be distinguished; one is characterized by complete or nearly complete absence of spiral sculpture (*A. abyssalis* n. sp., *A. obliquiplicata* n. sp., *A. dendritoplicata* n. sp. and *A. kawamurai*), the other, containing the remaining species treated herein, by the presence of variably developed spiral sculpture. It should be emphasized that the number of spiral ribs on the body whorl, being an ontogenetically and geographically variable feature, allows only statistical differentiation of species (figures 117, 118, 138).



Figures 2–10. Radulae of *Antiplanes* spp. Shell lengths and catalog numbers are given in parentheses. **2.** *Antiplanes dendritoplicata* n. sp., paratype (28.3 mm, ZIN N 6/54581); **3.** *A. obliquiplicata* n. sp., paratype (40.3 mm, ZM N Lc 6899); **4.** *A. spirinae* n. sp., paratype (22.4 mm, ZM N Lc 6905); **5.** *A. isaotakii* (Habe, 1958) (30.8 mm); **6.** *A. kurilensis* n. sp., paratype (28.8 mm, ZIN N 1/54583); **7, 8.** *A. habei* n. sp. **7.** holotype (38.0 mm, ZM N Lc 6909); **8.** paratype (23.1 mm, ZM N Lc 6910); **9, 10.** *A. vinosa* (Dall, 1874). **9.** (36.3 mm), **10.** (28.6 mm). Scale bars all 100 μm.



Figures 11–17. Radulae of *Antiplanes sanctiioannis* (Smith, 1875). The collection locality and shell length of individual specimens follow. **11.** Sakhalin Bay, 45.0 mm. **12.** Sakhalin Bay, 41.9 mm; **13.** Tatar Strait, 38.0 mm; **14.** Sakhalin Bay, 36.0 mm; **15.** Southern Kurile Islands, 34.5 mm; **16.** Eastern Kamchatka, 42.0 mm; **17.** Tatar Strait, 25.0 mm. Scale bars all 100 μm.

It is interesting to note that similar patterns of morphological variation occur in different species. Specimens of *A. sanctiioannis* from Sakhalin Bay have fewer ribs on their body whorl than individuals from the Kurile Islands. The same pattern is seen in *A. vinosa*, a sister species of *A. sanctiioannis*.

The morphology of the radula offers additional characters of taxonomic importance. Though the form of the marginal teeth was similar in all species (figures 2–17), rates of radular growth permitted species to be segregated into three groups: those with rapidly, moderately and slowly growing marginal teeth (figure 18). A geographical component to the variability of this character was observed. However, comparisons of specimens of the same size from the same locality showed distinct differences between species. In figure 18, points representing different species from the same locality are connected by dotted lines.

The groups of species isolated on the basis of radular growth pattern also differed in the degree of spiral sculpture. Species with the most slowly growing marginal teeth (*A. dendritoplicata* n. sp. and *A. obliquiplicata* n. sp.) generally lack spiral sculpture. Species with moderate marginal tooth growth rates (*A. sanctiioannis*, *A. vinosa*, *A. spirinae* n. sp., and *A. kurilensis* n. sp.) are characterized by more numerous and less developed spiral cords than the group of species with rapid marginal tooth growth (*A. habei* n. sp. and *A. isaotakii*). As with the variation in marginal tooth growth rates, species and species groups based on shell sculpture can only be distinguished statistically.

In some cases, the relative height of the body whorl was also useful for distinguishing similar species. Pairs of species such as *A. sanctiioannis* and *A. kurilensis* n. sp. as well as *A. dendritoplicata* n. sp. and *A. obliquiplicata* n. sp. (figure 46) were readily distinguished by this character.

The systematics of the genus *Antiplanes* were difficult to discern using traditional techniques due to high ontogenetic and geographical variability of nearly all generally accepted diagnostic characters. We have been able to distinguish close but distinct species by using graphs

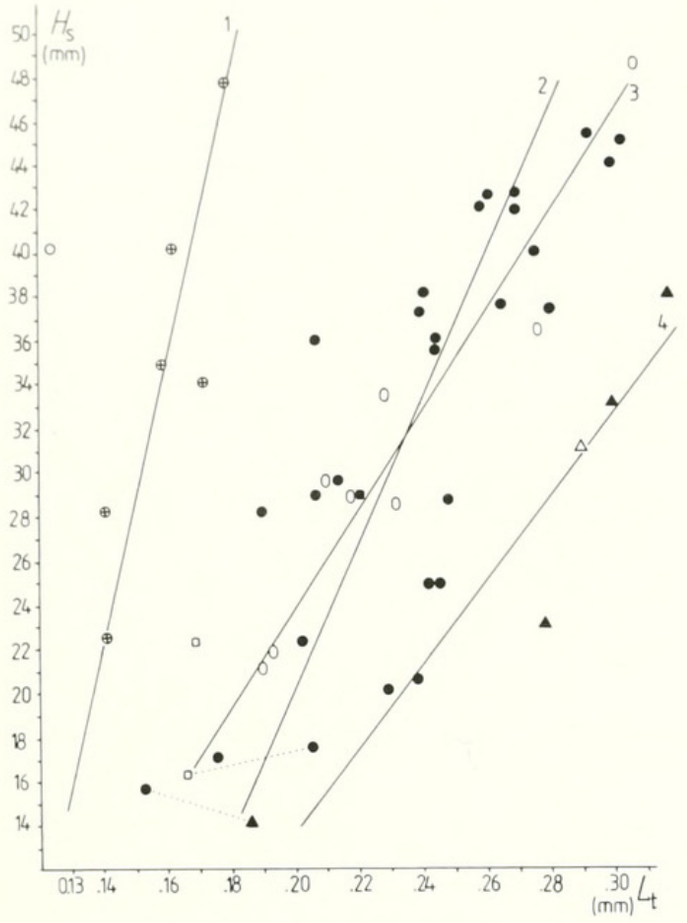


Figure 18. Rates of radular growth in species of *Antiplanes*. Crossed circles—*A. dendritoplicata* n. sp.; open squares—*A. spirinae* n. sp.; open circles—*A. obliquiplicata* n. sp.; solid circles—*A. sanctiioannis* (Smith); open ovals—*A. vinosa* (Dall); open triangles—*A. isaotakii* (Habe); solid triangles—*A. habei* n. sp. The lines of regression: 1. *A. dendritoplicata* n. sp.; 2. *A. sanctiioannis* (Smith); 3. *A. vinosa* (Dall); 4. *A. habei* n. sp. Lt—mean length of marginal tooth, Hs—shell length.

and regression analyses of various characters relative to shell height. This approach forms the basis of the following systematic treatment of this genus.

SYSTEMATICS

Family TURRIDAE Swainson, 1840
Subfamily Turriculinae Powell, 1942
Genus *Antiplanes* Dall, 1902

Dall, 1902:513 (type species, by original designation—*Pleurotoma* (*Surcula*) *perversa* Gabb, 1865).

Rectiplanes Bartsch, 1944b:59 (type species, by original designation—*Pleurotoma* (*Antiplanes*) *santarosana* Dall, 1902).

Rectiplanes (*Rectisulcus*) Habe, 1958:184 (type species, by original designation—*Rectiplanes* (*Rectisulcus*) *motojimai* Habe, 1958).

Diagnosis of the genus: Shell large (to 72 mm), dextral or sinistral, fusiform, covered by smooth, thick periostracum. Axial sculpture absent. Spiral sculpture may be absent or composed of ribs and dendritic threads (figure 19, DL) that may be obliquely and irregularly disposed, with ramifying small threads radiating from extremities of anal sinus growth lines. Anal sinus deep, located on shoulder or near periphery. Siphonal canal long, occasionally slightly curved. Operculum (figures 20–25) large, drop-shaped, terminally nucleated, filling the aperture. Radula "nontoxoglossate", consisting of proximally bifurcated marginal teeth and of vestigial rachidian teeth.

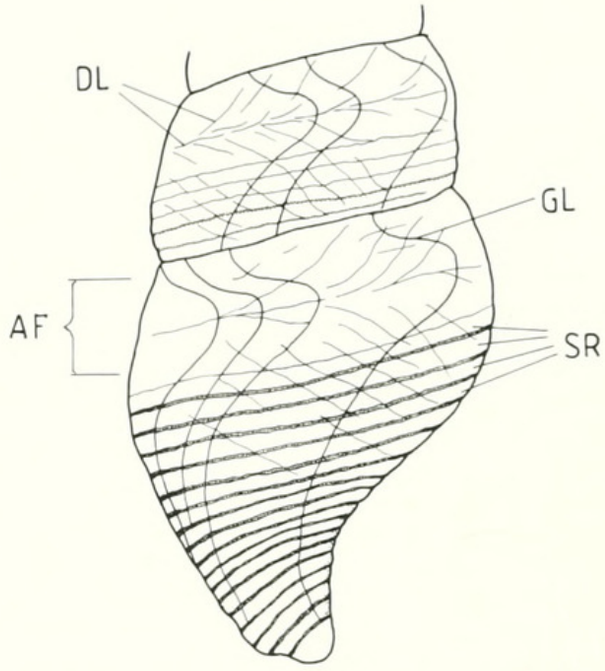
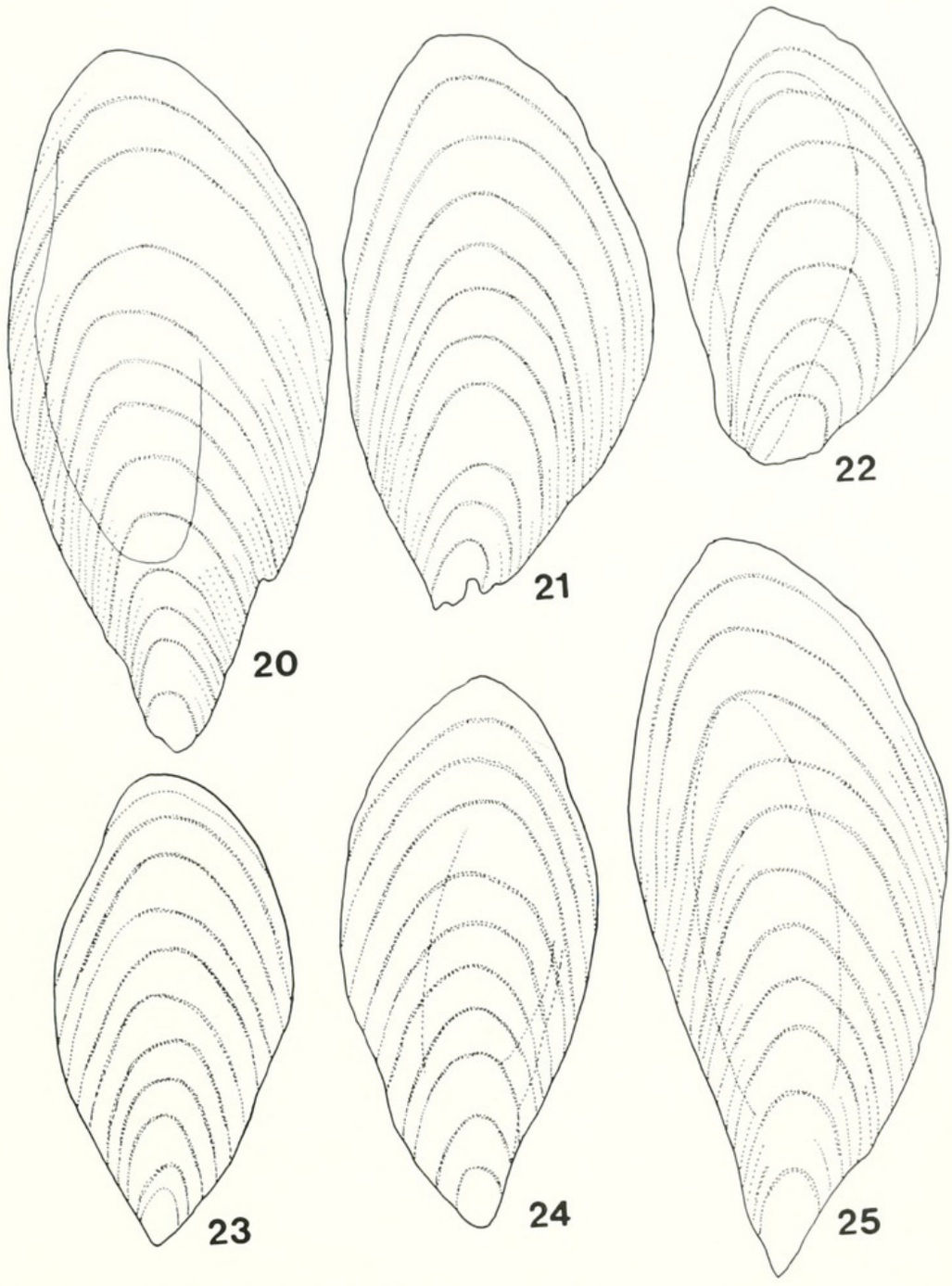


Figure 19. Diagrammatic representation of the shell base of *Antiplanes habei* n. sp. AF—anal fasciole, DL—dendritic ribs, GL—growth lines, SR—spiral ribs.

Type species: *Pleurotoma* (*Surcula*) *perversa* Gabb, 1865, the originally designated type species of *Antiplanes*, is a primary homonym of *Pleurotoma perversa* Philippi, 1846. Grant and Gale (1931) considered *P. perversa* Gabb to be a synonym of *P. voyi* Gabb, 1869. However, the original descriptions and illustrations demonstrate that these are different species. Indeed, one of them (*P. perversa*) is sinistral while the other (*P. voyi*) is dextral. As no available name exists for *Pleurotoma perversa* Gabb, 1865, we here propose *Antiplanes gabbi*, ***nomen novum***, as a replacement name. Syntypes (UCMP 15929 and 31547) Catalina Island, California (Recent); (UCMP 15930), Pleistocene of San Pedro, California (Coan & Bogan, 1988).

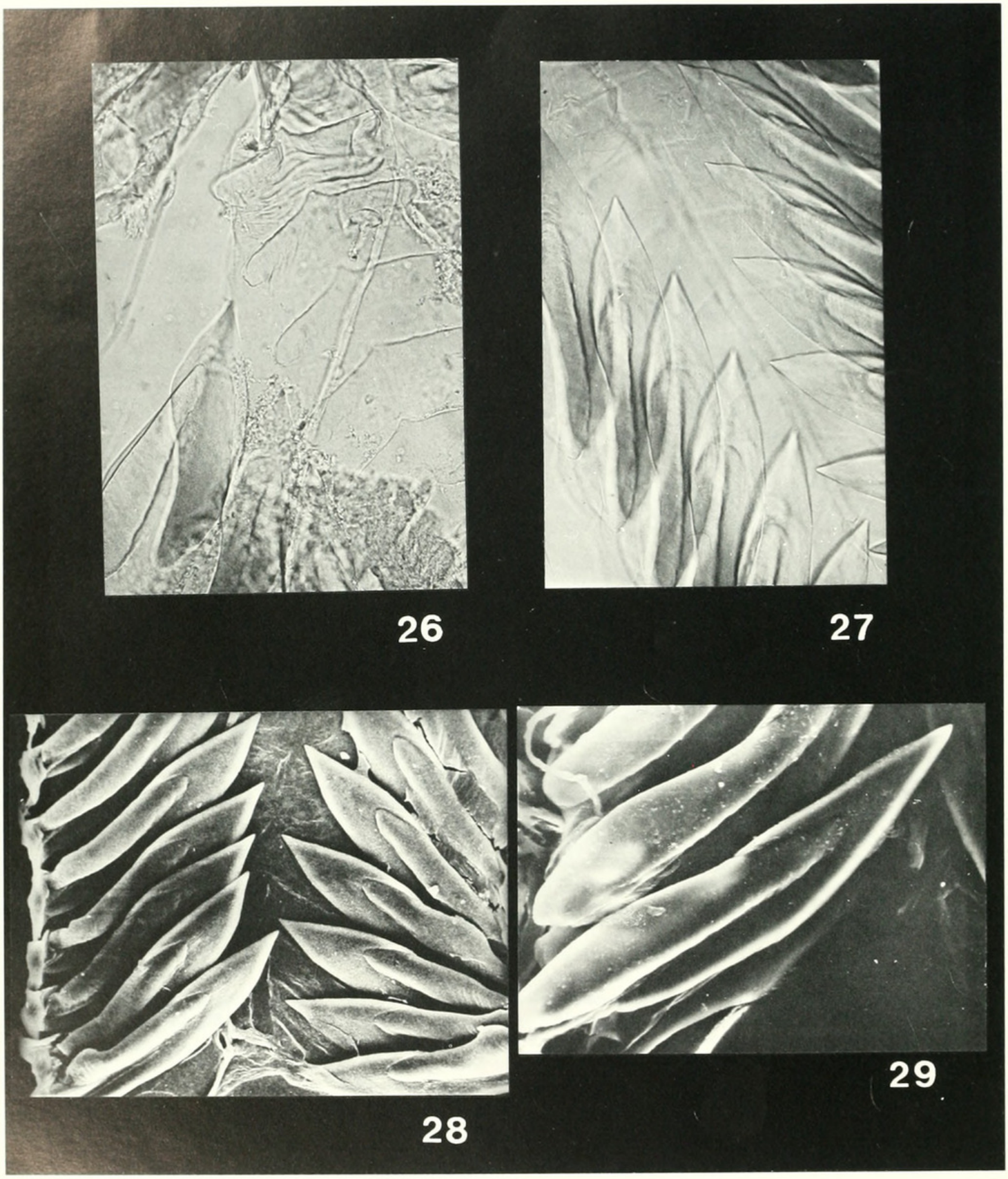
Distribution: Species of *Antiplanes* live in the northern part of the Pacific Ocean from California to British Columbia, along the American coast and from Honshu, Japan to the Gulf of Anadyr, Bering Sea, along the Asian coast, at sublittoral to upper abyssal depths. In the Bering Sea, *Antiplanes* were found in western, eastern and central parts. Neither the literature nor samples at our disposal contain records of *Antiplanes* from the Gulf of Alaska. According to our data, western American (southward of the Gulf of Alaska) and Asian (including the Bering Sea) faunas have no species in common.



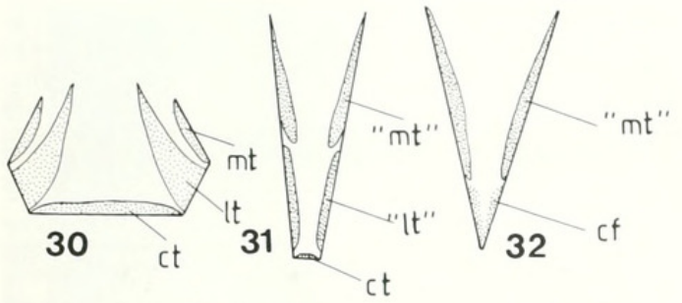
Figures 20–25. Opercula of *Antiplanes* spp. **20.** *A. obliquiplicata* n. sp., holotype, ZM N Lc 6898, 40.3 mm. **21.** *A. dendritoplicata* n. sp., paratype, ZIN N 6/54581, 28.3 mm. **22.** *A. spirinae* n. sp., paratype, ZM N Lc 6905, 16.3 mm. **23.** *A. habei* n. sp., paratype, ZIN N 1/54627, 33.3 mm. **24.** *A. vinosa* (Dall), 36.3 mm. **25.** *A. sanctiioannis* (Smith), 42.7 mm.

Fossil species of *Antiplanes* are known from the Eocene of North America (*Drillia cooperi* Dickerson, according to Grant and Gale, 1931). In the eastern Pacific, the genus was frequently found in Pliocene deposits of Oregon and Washington (Grant & Gale, 1931; Addicott, 1976) and in Pliocene and Pleistocene of California (Grant & Gale, 1931). In the western Pacific, earliest occurrences of the genus were recorded from the Middle Miocene of Japan (*A. sadoensis* (Yokoyama)—Chinzei, 1959, and *A. sanctiioannis* (Smith)—Amano, 1983). Species of *Antiplanes* are abundant in Pliocene deposits of Honshu and Hokkaido, Japan (Masuda & Noda, 1976). *Antiplanes voyi* and a dextral *Antiplanes* sp. were found in the upper Pliocene to lower Pleistocene of eastern Kamchatka (Petrov, 1982).

Remarks: The genus *Rectiplanes* was erected by Bartsch (1944b) to contain dextral species only. No other characters distinguishing *Rectiplanes* and *Antiplanes* can be identified. Since we do not consider direction of shell coiling to be of more than a species level character, *Rectiplanes* is regarded as a synonym of *Antiplanes*.



Figures 26–29. Light (26, 27) and SEM (28, 29) micrographs of radulae. **26–28.** *Antiplanes sanctiioannis* (Smith). **29.** *A. vinosa* (Dall).



Figures 30–32. Diagrammatic representations of transverse sections of the radula in the radular sac. **30.** *Olivella borealis* Golikov, 1967. **31.** *Splendrillia chatamensis* Sysoev and Kantor, 1989. **32.** *Antiplanes sanctiioannis* (Smith, 1875). cf—"central formation", ct—central tooth, lt—true lateral tooth, "lt"—the so called "lateral" tooth of Turridae, mt—true marginal tooth, "mt"—the so called "marginal" tooth of Turridae.

Habe (1958) established the subgenus *Rectisulcus* for dextral species with well developed spiral ribs. As there is a continuum in the degree of spiral rib development, we follow Powell (1966), in synonymizing *Rectisulcus* with *Antiplanes*.

Varying opinions exist as to the composition of the transverse rows of teeth in the *Antiplanes* radula. A reduced central tooth having the form of a narrow plate pointed at both ends occurs in the eastern Pacific species *A. santarosana* and *A. thalaea* (Powell, 1966, figures 57, 58). However, McLean (1971) indicated that eastern Pacific species of *Antiplanes* lacked central teeth. Structures superficially resembling the central teeth of other Turriculinae were seen in *Antiplanes* by means of light microscopy (figures 26, 27). Only the anterior and parts of the lateral borders of these optically transparent structures were clearly seen in unstained preparations (figure 26). When the radula was stained with Orange G and Aniline Blue, these structures appeared to be paired and symmetrical (figure 27). However, scanning electron microscopy showed that there were no distinct tooth plates on the central part of the radular membrane (figures 28, 29). The membrane had only indistinct folds that are similar to those of some other Turriculinae.

The manner in which the radular membrane is folded within the radular sheath is significant for evaluating the nature of these central structures. The radular membrane of prosobranch mollusks is folded within the radular sheath. These folds occur between groups of teeth, or between separate teeth if the radulae are greatly oligomerized. Taenioglossate radulae, for example, have two pairs of folds, one between the central and lateral teeth, the other between the lateral and marginal teeth. The same pattern occurs in those Neogastropoda that have five teeth per transverse row (*Olivella*, figure 30). However, in turrids with five teeth per transverse row (subfamily Clavinae) there is only one pair of folds, placed between the central and lateral teeth. We have also observed this pattern in two species of *Splendrillia* (figure 31).

Study of the radula of *Antiplanes* shows that the radular membrane has but a singular fold situated exactly along the middle of the "central structure." Moreover, the membrane can be easily torn along this bend. In our opinion this suggests that the "central formation" is a rudiment of a pair of lateral teeth but not of the central tooth. We propose that the central tooth was completely reduced during evolution, and that the paired folds of the membrane have then grown nearer and fused into a single bend. Maes (1983) proposed a similar evolutionary pathway for *Crassispira* (*Crassiclava*) *apicata* (Reeve) (figures 31, 32), and referred to these structures as "soft lateral teeth". Although studies of the embryonic development of the radula of *Antiplanes* would shed further light on this question, such data is presently not available.

The competing hypotheses, one of weakening of the central tooth and complete reduction of lateral teeth, the other of loss of the central tooth along with regaining of the weakened lateral teeth, cannot be fully resolved at this time.

WESTERN PACIFIC SPECIES ERRONEOUSLY ATTRIBUTED TO *ANTIPLANES*

Rectiplanes (*?*) *yukiae* Shikama, 1962. Shikama, 1962: 50, pl. 3, figs. 3a,b, 4a,b.

Type locality: Off Choshi, eastern Honshu—Japan, 250–300 fms. The species was subsequently reassigned to the genus *Benthodaphne* Oyama, 1962 (Okutani, 1964, 1968).

Rectiplanes (*Rectisulcus*) *hayashii* Shikama, 1977. Shikama, 1977:19, pl. 3, fig. 12a,b.

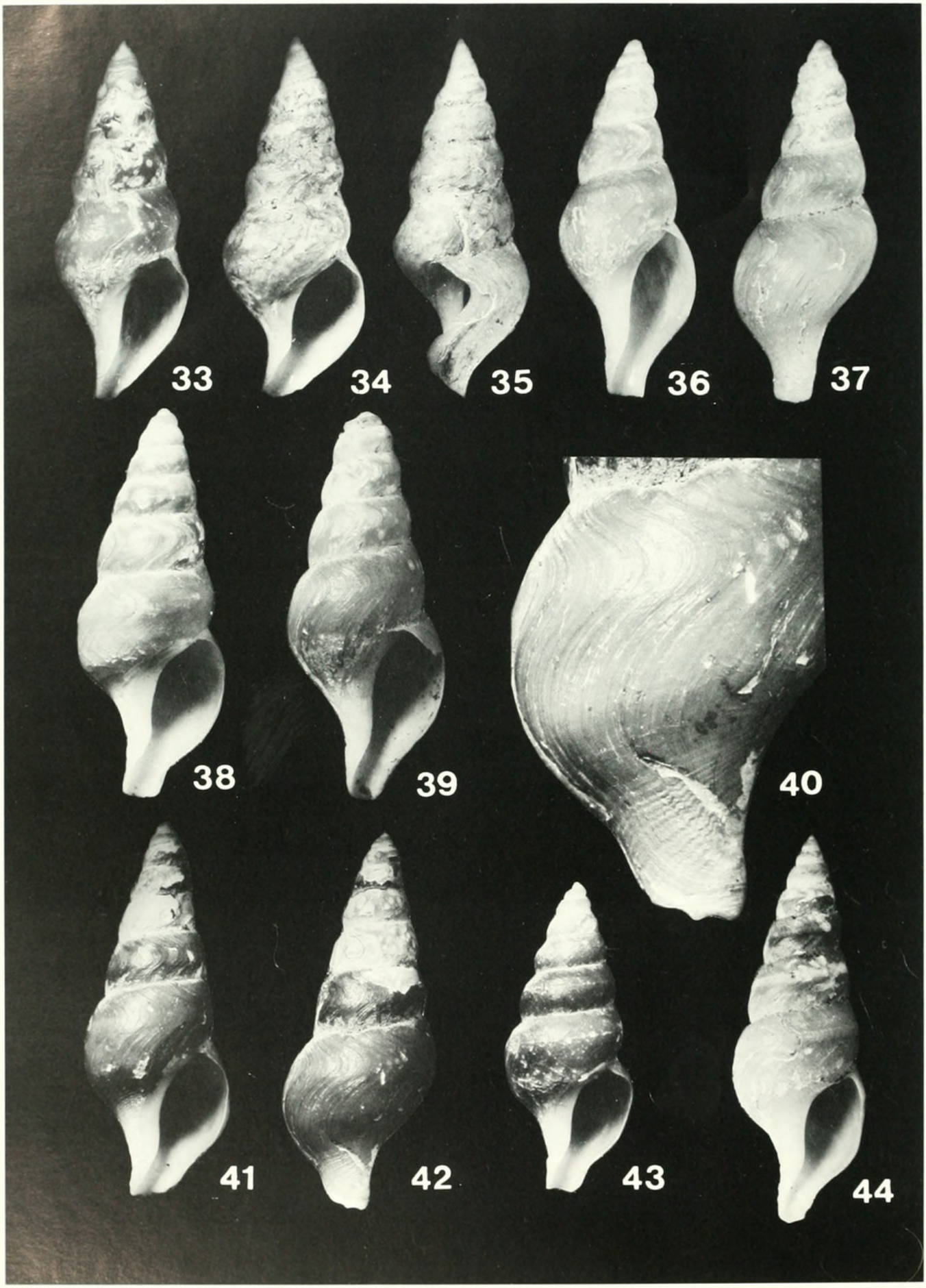
Type locality: Ensyu-nada, south-western Japan. This species has well developed axial sculpture and is here referred to the genus *Comitas* Finlay, 1926.

RECOGNIZED SPECIES OF *ANTIPLANES*

Antiplanes abyssalis new species
(figures 33–35, 45)

Material examined: Holotype: R/V 'Vityaz', 39th cruise, sta. 5603, south-east of Simushir, Kurile Islands, 46°22'N, 153°03'E, depth 3,175–3,250 m, 15.VII.1966 (ZM N Lc 6889); paratype R/V 'Vityaz', 14th cruise, sta. 2210, south-east of southern Kamchatka, 50°01.8'N, 157°39.2'E, depth 2,430–2,670 m, 24.VI.1953 (ZM N Lc 6890).

Description of holotype: Shell slender, with slightly curved axis, consisting of 6.5 teleoconch whorls and at least 1.5 heavily eroded protoconch whorls. Whorl profile angulated at periphery, whorl shoulder concave. Sutures deep. Body whorl high, comprises about 0.6 of shell height. Shell base weakly convex, passing gradually and without bending into a moderately elongate siphonal canal. Growth lines distinct. Spiral sculpture nearly absent, represented by single somewhat wavy riblet on anal fasciole and by marked dendritic ribs that reach upper and lower sutures of spire whorls but disappear on shell base. Anal sinus wide, rounded. Aperture wide, elongate-oval, poor-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ly differentiated from siphonal canal, outer lip attached to columella at acute angle. Columella straight, covered with narrow, white, glossy callus. Color light-yellow. Periostracum thin, smooth, glossy, fitting closely to hypostracum.

Dimensions of holotype: Shell height 31.0 mm, body whorl height 18.7 mm, aperture height 14.2 mm, shell diameter 12.0 mm.

Remarks: The paratype differs from the holotype in having a somewhat darker periostracum, a less concave profile of the shoulder, and a wider siphonal canal. The spiral riblet on the anal fasciole is weaker in the paratype.

This species differs from *Antiplanes dendritoplicata* n. sp., its nearest relative, in lacking spiral ribs on the shell base and siphonal canal, and from *A. obliquiplicata* n. sp. in having a higher body whorl as well as in whorl profile.

Distribution: This species was found along the Kurile-Kamchatka trench at depths of 2430–3250 m (figure 45).

Antiplanes dendritoplicata new species
(figures 2, 21, 36–44, 45)

Material examined: Holotype (ZM N Lc 6891) and 3 paratypes (ZM N Lc 6892): R/V 'Vityaz', 39th cruise, sta. 5641, east of Iturup, southern Kurile Islands, 44°46′N, 148°45′E, depth 472–479 m, Sigsbee trawl, 10.IX.1966; paratypes: R/V 'Vityaz', 12th cruise, sta.1779, northeastern Okhotsk Sea, depth 464 m, Sigsbee trawl, 13.X.1952 (2 specimens—ZM N Lc 6893); 12th cruise, sta. 1831, northwestern Okhotsk Sea, 56°57.5′N, 145°57.0′E, depth 196 m, Sigsbee trawl, mud, 15.X.1952 (2 specimens—ZM N Lc 6894); 24th cruise, sta. 3578, east of Honshu, 38°35.0′N, 142°53.3′E, depth 1,641 m, Sigsbee trawl, clay, 11.V.1957 (1 specimen—ZM N Lc 6895); 39th cruise, sta. 5638, east of Iturup, 44°36′N, 149°07′E, depth 1,675–1,845 m, Galathea trawl, 10.IX.1966 (1 specimen—ZM N Lc 6896); 52th cruise, sta. 6671, east of Honshu, 40°12.0′N, 143°35.8′E, depth 2,400–2,720 m, Sigsbee trawl, 23.VI.1972 (1 specimen—ZM N Lc 6897); Okhotsk Sea, sta. 139/20, 55°45′N, 145°50′E, depth 218 m, sandy mud, 1.VIII.1930, coll. P. V. Ushakov (3 specimens—ZIN N 1/54576); R/V 'Toporok', sta. 63, southeastern Sakhalin, 46°49.5′N, 143°52.3′E, depth 187 m, 4.IX.1947 (1 specimen—ZIN N 2/54577); sta. 70, southeastern Sakhalin, 46°26.2′N, 143°22.0′E, depth 103 m, mud with gravel, 6.IX.1947 (1 specimen—ZIN N 3/54578); sta. 13-a, northwest of Hokkaido, 44°47.6′N, 144°29.8′E, depth 700 m, 26.VIII.1948 (3 specimens—ZIN N 4/54579); sta. 17, off Shikotan, 43°37.1′N, 147°02.8′E, depth 1,450–1,530 m, Sigsbee trawl, mud, 28.VIII.1948 (2 specimens—ZIN N 5/54580); sta. 100, off Iturup, 44°42.0′N, 147°56.7′E, depth 299 m, 14.IX.1949 (1 specimen—ZIN N 6/54581); sta. 101, off Iturup, 44°20.8′N, 148°24.0′E, depth 414 m, 14.IX.1949 (1 specimen—ZIN N 7/54582).

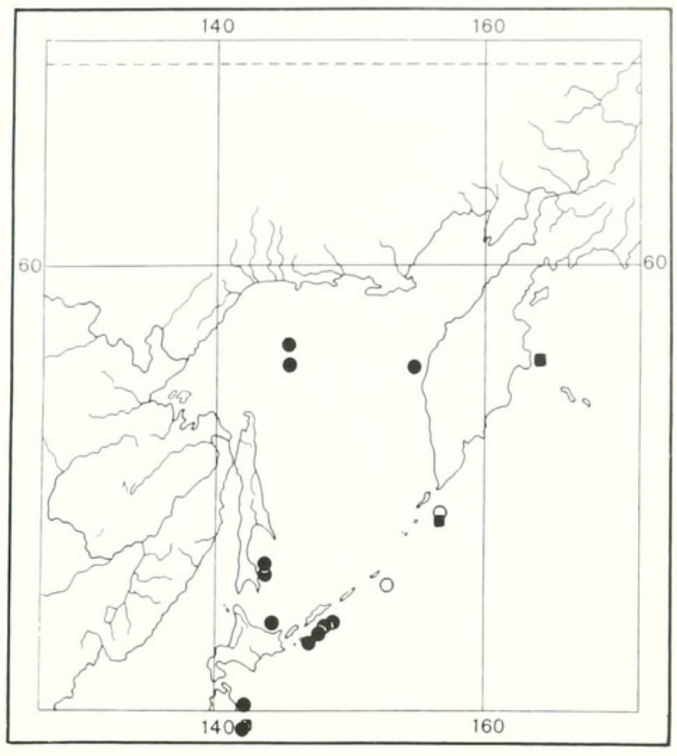

Figure 45. Geographic distribution of *Antiplanes abyssalis* n. sp. (open circles), *A. dendritoplicata* n. sp. (solid circles), *A. obliquiplicata* n. sp. (solid squares).

Description of holotype: Shell slender, fusiform, composed of 5 teleoconch whorls and 1.5 heavily eroded protoconch whorls. Surface of upper 2.5 teleoconch whorls heavily eroded, rose-colored. Coiling axis slightly curved. Body whorl high, convex, comprising 0.64 of shell height. Teleoconch whorls convex, evenly rounded, divided by deep sutures. Shell base weakly convex, almost flat, passing into long siphonal canal without pronounced bend. Growth lines distinct. Spiral sculpture of indistinct, interrupted riblets on anal fasciole (3–4 on body whorl, 2–3 on penultimate whorl) and of moderately developed dendritic ribs that reach sutures on spire whorls but become smooth on shell base. Siphonal canal with 8 indistinct spiral ribs separated by shallow grooves. Aperture

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Figures 33–44. Shells of *Antiplanes* spp. **33–35.** *Antiplanes abyssalis* n. sp. **33.** holotype, ZM N Lc 6889, 31.0 mm. **34, 35.** paratype, ZM N Lc 6890, 36.2 mm. **36–44.** *Antiplanes dendritoplicata* sp. nov. **36, 37.** Holotype, ZM N Lc 6891, 41.4 mm. **38.** Paratype, off Shikotan, Kurile Islands, ZIN N 5/54580, 35.2 mm. **39.** Paratype, eastward off Iturup, southern Kurile Islands, ZM N Lc 6892, 32.6 mm. **40.** The shell base of 42, note the spiral ribs on the canals. **41, 42.** Paratype, northwest of Hokkaido, ZIN N 4/54579, 37.0 mm. **43.** Paratype, east of Chonshu, ZM N Lc 6897, 27.0 mm. **44.** Paratype, northwestern Okhotsk Sea, ZM N Lc 6894, 47.7 mm.

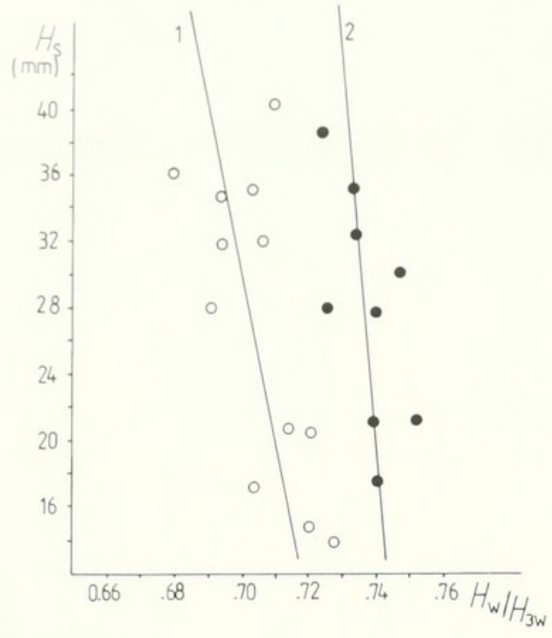

Figure 46. Comparison of the relative height of the body whorl of *A. dendritoplicata* n. sp. (open circles, 1—line of regression) and *A. obliquiplicata* n. sp. (solid circles, 2—line of regression). The shell height is plotted along the abscissa, the ratio between the body whorl height to the height of the last 3 whorls is plotted along the ordinate.

high, elongate, oval. Columella slightly thickened by white, glossy callus. Siphonal canal differentiated from aperture by its parallel margins. Shell color light-olive. Periostracum thin, glossy.

Dimensions of holotype: Shell height 41.4 mm, body whorl height 26.6 mm, aperture height 20.7 mm, shell diameter 16.0 mm.

Remarks: Paratypes have less convex whorls, more distinct and closely set riblets on the anal fasciole (up to 4 on spire whorls), a more weakly developed bend at juncture of the body whorl periphery and the shell base, and a shorter siphonal canal that is better differentiated from the shell base. Ribs on the siphonal canal of paratypes may be more numerous (up to 15) and extend onto the shell base.

Radulae of 6 paratypes were examined (figure 2). Radular teeth are small, the shell height/mean marginal tooth length ratio ranges from 159.6 (shell height 22.5 mm) to 266.5 (shell height 47.7 mm). Mean length of marginal teeth increases slowly. The linear regression equation is:

$$Y = 0.1052 + 0.0016\ X,$$

where Y is the mean length of marginal teeth and X the shell height.

Antiplanes dendritoplicata n. sp. is most similar to *A. obliquiplicata* n. sp., and the variable shell forms of both species overlap. However, *A. dendritoplicata* always has ribs on the siphonal canal (figure 40). These ribs are invariably absent in *A. obliquiplicata* (figure 52). These two species can also be distinguished by significant differences in the relative height of the body whorl (body whorl height/height of last three last whorls—figure 46). The relative height of the body whorl decreases linearly during growth. In young individuals (shell height <30 mm), differences between species are less clearly discerned, but these two species differ significantly in mean values. The regression equations are:

A. dendritoplicata

$$Y = 0.7344 - 0.0011\ X$$

A. obliquiplicata

$$Y = 0.7485 - 0.0004\ X,$$

where Y is the relative height of the body whorl and X is the height of 3 last whorls.

Distribution: This species was recorded from eastern Honshu to the northern part of the Okhotsk Sea at depths from 103 m (south-eastern Sakhalin) to 2,720 m (east of Honshu) (figure 45).

Antiplanes obliquiplicata new species
(figures 3, 20, 45, 47–52)

Material examined: Holotype (ZM N Lc 6898) and 6 paratypes (ZM N Lc 6899): R/V 'Vityaz', 24th cruise, sta. 3577, E of Honshu, 38°40.1′N, 143°29.3′E, depth 3042 m, mud, 10.V.1957; paratypes: R/V 'Vityaz', 5th cruise, sta. 618, western Bering Sea, 57°03.5′N, 168°30.5′E, depth 3,875 m, Sigsbee trawl, mud, 25.IX.1950 (1 specimen—ZM N Lc 6900); 14th cruise, sta. 2209, E of southern Kamchatka, 49°46′N, 157°48′E, depth 3,660 m, Sigsbee trawl, 23.V.1953 (4 specimens—ZM N Lc 6901); 24th cruise, sta. 3578, E of Honshu, 38°35.0′N, 142°53.3′E, depth 1641 m, Sigsbee trawl, clay, 11.V.1957 (1 specimen—ZM N Lc 6902).

Description of holotype: Shell slender, fusiform, composed of 8 whorls. Three upper whorls heavily eroded. Two upper whorls considerably smaller in diameter, probably representing protoconch. Body whorl convex, comprising 0.56 of shell height. Shell covered by thin, olivaceous, somewhat glossy, non-exfoliating periostra-

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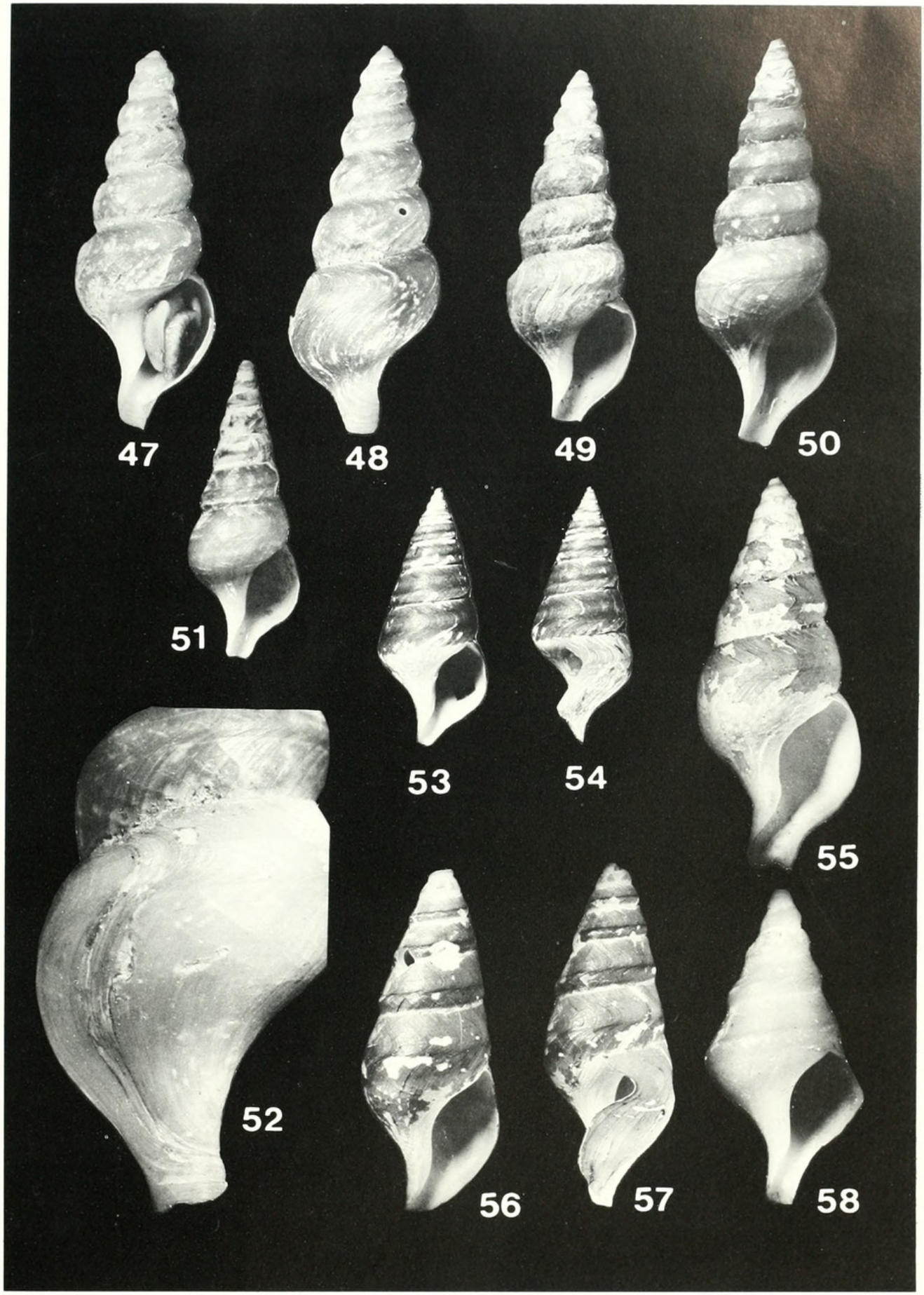
Figures 47–58. Shells of *Antiplanes* spp. **47–52.** *Antiplanes obliquiplicata* n. sp. **47, 48.** Holotype, ZM N LC 6898, 40.3 mm. **49.** Paratype, east of Chonshu, ZM N Lc 6899, 36.2 mm. **50.** Paratype, east of Chonshu, ZM N Lc 6902, 32.0 mm. **51.** Paratype, the same sample as 49, ZM N Lc 6899, 20.8 mm. **52.** The shell base of the holotype, note the absence of spiral ribs on the canal. **53–58.** *Antiplanes kawamurai* (Habe, 1958). **53, 54.** Holotype, NSMT N 38598, 35.8 mm. **55.** Off Shikotan, Kurile Islands, ZIN N 56322, 52.1 mm. **56, 57.** East of Chonshu, 30.6 mm. **58.** The same sample as 56, 57, 11.7 mm.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cum. Teleoconch whorls highly convex, evenly rounded, separated by deeply impressed suture. Shell base extremely convex, giving rise to long, broad, curved siphonal canal. Growth lines thin, indistinct. Axial folds oriented parallel to growth lines below anal fasciole on upper whorls, absent on body whorl. Anal sinus deep, wide, rounded. Spiral sculpture of well-developed dendritic threads that reach sutures on spire whorls and siphonal canal on body whorl. Spiral riblets (2–3) can be traced on anal fasciole of upper whorls. Spiral sculpture absent on shell base and siphonal canal. Aperture elongate-oval, well differentiated from siphonal canal. Columella concave, covered by white, glossy callus.

Dimensions of holotype: Shell height 40.3 mm, body whorl height 22.7 mm, aperture height 18.0 mm, shell diameter 15.5 mm.

Remarks: Radular teeth of the paratype (figure 3) are small. Mean length of marginal teeth is 0.124 mm (shell height/tooth length = 325). The shoulders and shell bases of the paratypes are weakly angular; their whorls may be more flattened. The anal fasciole and the part of the whorl nearest to the upper suture may be covered with thin spiral cords. The canal may be straighter and more differentiated from the aperture.

This species is most similar to A. *dendritoplicata*, and may be differentiated from that species as discussed in the remarks for that species.

Distribution: *Antiplanes obliquiplicata* ranges from Honshu to eastern Kamchatka at depths of 1,641 to 3,875 m (figure 45).

Antiplanes kawamurai (Habe, 1958)
(figures 53–58)

Rectiplanes kawamurai—Habe, 1958:181–184, text-fig. 1; Shikama, 1962:50–51, pl. 3, figs. 1a,b, 2a; Okutani, 1964:423, pl. 14, fig. 6; 1968:37, pl. 3, fig. 7.

Type specimens: Holotype (NSMT N 38598), shell height 35.8 mm; paratype (NSMT N 52671), shell height 34.8 mm.

Type locality: Off Choshi, Chiba Pref., Honshu, Japan, in 183–274 m.

Material examined: Off Shikotan, Kurile Islands, 43°35.5′N, 147°20.5′E, depth 1,450–1,530 m, mud, 28.VII.1948 (1 specimen ZIN N 56322); E of Honshu, Japan (4 specimens).

Description: Shell light greenish or brownish, broadly fusiform, with flat-sided spire outline. Body whorl moderately convex, tapering rapidly to join broad, short siphonal canal. Whorls weakly convex, angulated below anal fasciole, nearly turreted in young specimens. Anal fasciole usually concave, with spiral sculpture absent or of indistinct threads. Dendritic cords well developed, reaching suture on spire whorls, occasionally reaching shell base. Aperture oval, broad, outer lip joining columella at right or obtuse angle. Shell height reaching 56 mm (Shikama, 1962).

Remarks: This species is easily distinguished from other species of *Antiplanes* with weakly developed spiral sculpture (*A. dendritoplicata*, *A. obliquiplicata*, *A. abyssalis*) by its broad shell and angulated whorls.

Distribution: *Antiplanes kawamurai* inhabits the eastern coast of Japan from Sagami Bay to the southern Kurile Islands (Shikotan Island), at depths of 1,520 m (Sagami Bay—Okutani, 1968) to 183 m (type locality).

Antiplanes sanctiioannis (Smith, 1875)
(figures 1, 11–17, 25, 26–28, 59–88, 100–103)

Pleurotoma (?*) *Sancti-Ioannis* Smith, 1875:416–417.
Pleurotoma Beringi Aurivillius, 1887:377, Taf. 13, fig. 3.
Pleurotoma (*Antiplanes*) *piona* Dall, 1902:514.
Antiplanes piona Dall, 1925:4, pl. 21, fig. 5.

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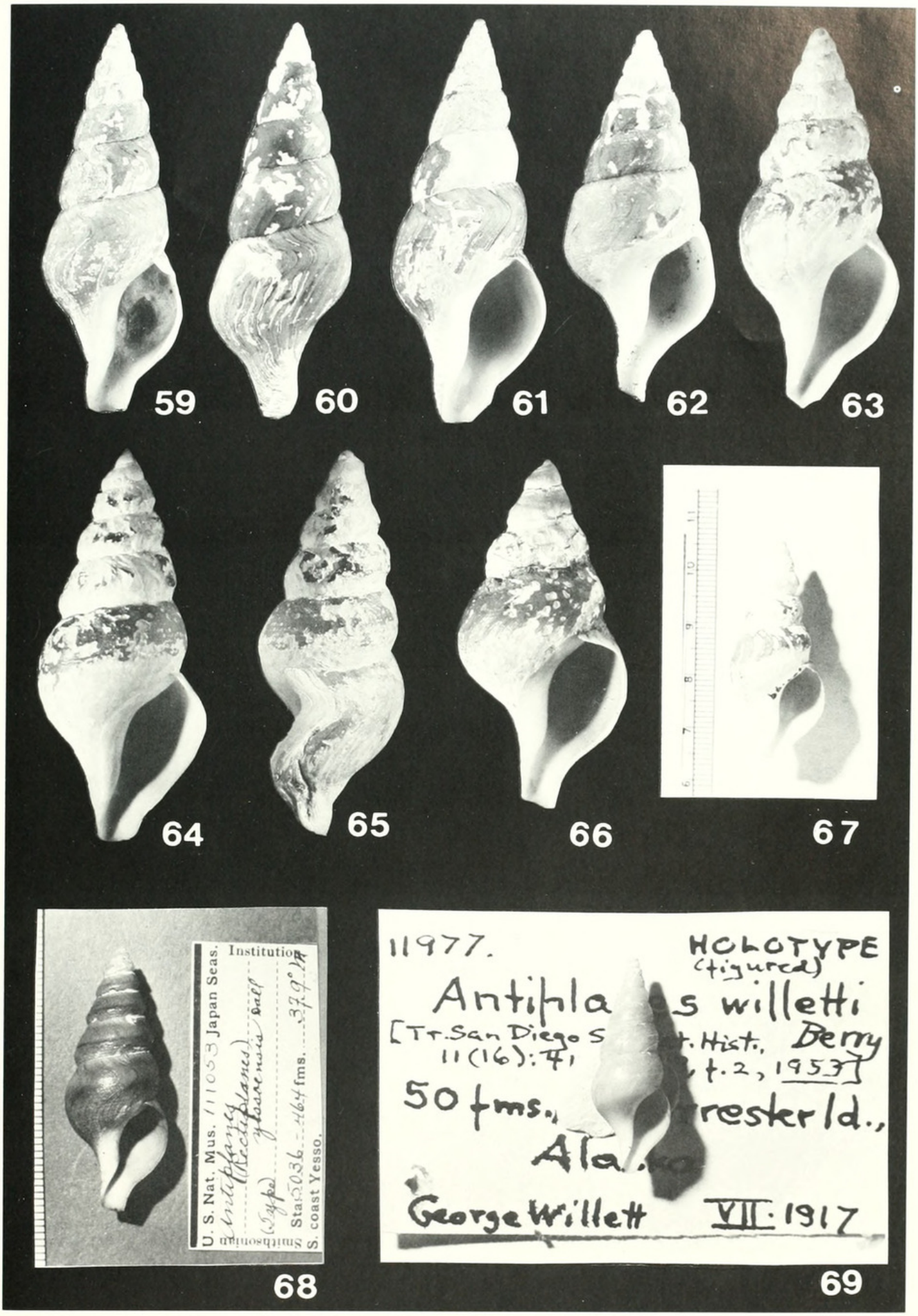
Figures 59–69. Shells of *Antiplanes* spp. **59–62.** *Pleurotoma sanctiioannis* Smith, 1875. **59, 60.** Lectotype, BM(NH) N 1873.8.6.16, 39.2 mm. **61, 62.** Paralectotypes, BM(NH) N 1873.8.6.16, 39.9, 23.2 mm. **63–66.** *Pleurotoma beringi* Aurivillius, 1887. **63, 64.** Lectotype, NSR N 1557, 38.3 mm. **65, 66.** Paralectotypes, NSR N 1557, 37.7, 16.6 mm. **67.** *Pleurotoma* (*Antiplanes*) *piona* Dall, 1902, holotype, USNM 109179, 42.0 mm. **68.** *Antiplanes yessoensis* Dall, 1925, holotype, USNM 111053, 39 mm. **69.** *Antiplanes willetti* Berry, 1953, holotype, 18.4 mm.

Figures 70–82. Shells of *Antiplanes sanctiioannis* (Smith, 1875). **70–73.** Tatar Strait, Okhotsk Sea (70, 71—39.3 mm, 72—35.1 mm, 73—33.8 mm). **74.** Sakhalin Bay, Northern Sakhalin, Okhotsk Sea (41.3 mm). **75.** Off Paramushir, northern Kurile Islands (38.2 mm). **76.** Off Onekotan, central Kurile Islands (37.2 mm). **77.** Tatar Strait, Okhotsk Sea (32.0 mm). **78.** Off Iona Island, northwestern Okhotsk Sea (30.4 mm). **79.** Off Iturup, southern Kurile Islands (32.1 mm). **80.** Off eastern Sakhalin, (38.9 mm). **81–82.** Northern part of Okhotsk Sea (81—34.3 mm, 82—40.6 mm).

Figures 83–99. Shells of *Antiplanes* spp. **83–88.** *Antiplanes sanctiioannis* (Smith, 1875). **83.** Tatar Strait, Okhotsk Sea (32.0 mm). **84.** Bristol Bay, eastern Bering Sea (34.0 mm). **85–88.** Bering Sea (85—31.7 m, 86, 87—29.6 mm, 88—39.9 mm). **89–93.** *Antiplanes kurilensis* n. sp. **89, 90.** Holotype, ZM N Lc 6903, 54.6 mm. **91.** Paratype, Kurile Islands, ZM N Lc 6904, 52.3 mm. **92.** Paratype, east off Shumshu, northern Kurile Islands, ZIN N 1/54583, 28.8 mm. **93.** Off Moneron Island, Tatar Strait, subfossil specimen, ZIN N 2/54584, 35.4 mm. **94–99.** *Antiplanes spirinae* n. sp. **94, 95.** Holotype, ZIN N 1/54585, 36.5 mm. **96–98.** Paratypes, of Simushir, central Kurile Islands, ZM N Lc 6905 (96—22.4 mm, 97—14.2 mm, 98—16.3 mm). **99.** The shell base of the holotype.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George Willett
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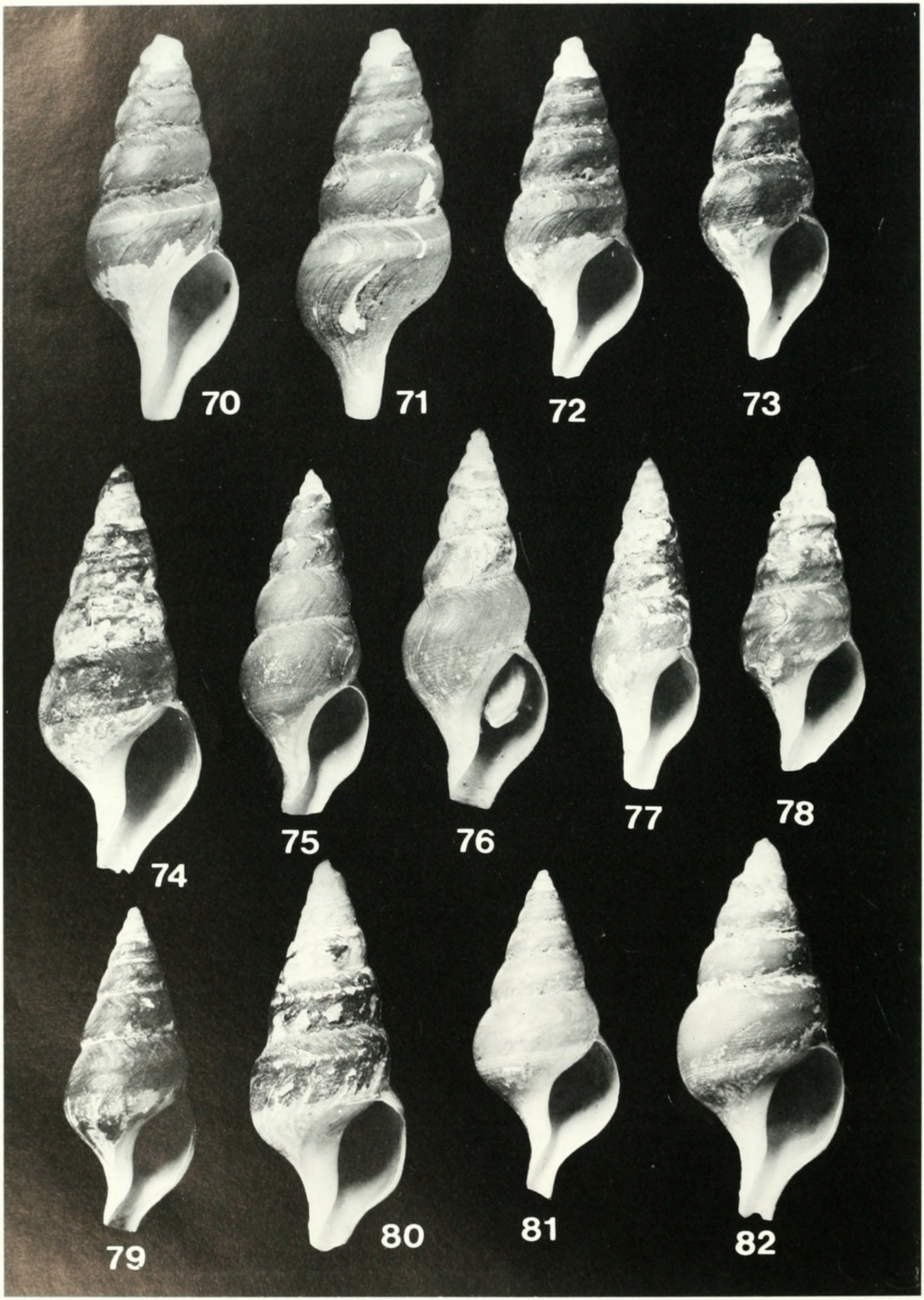
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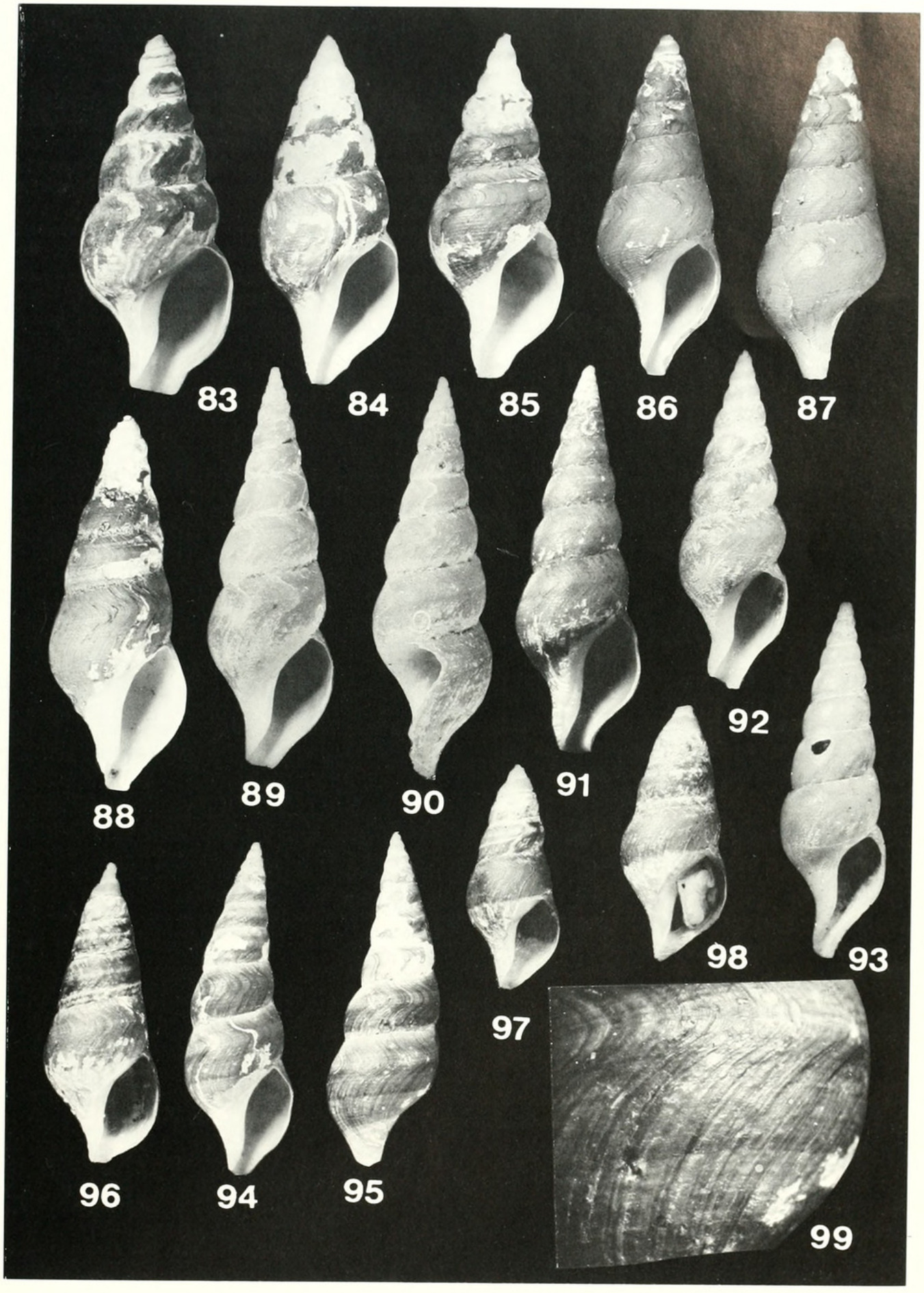
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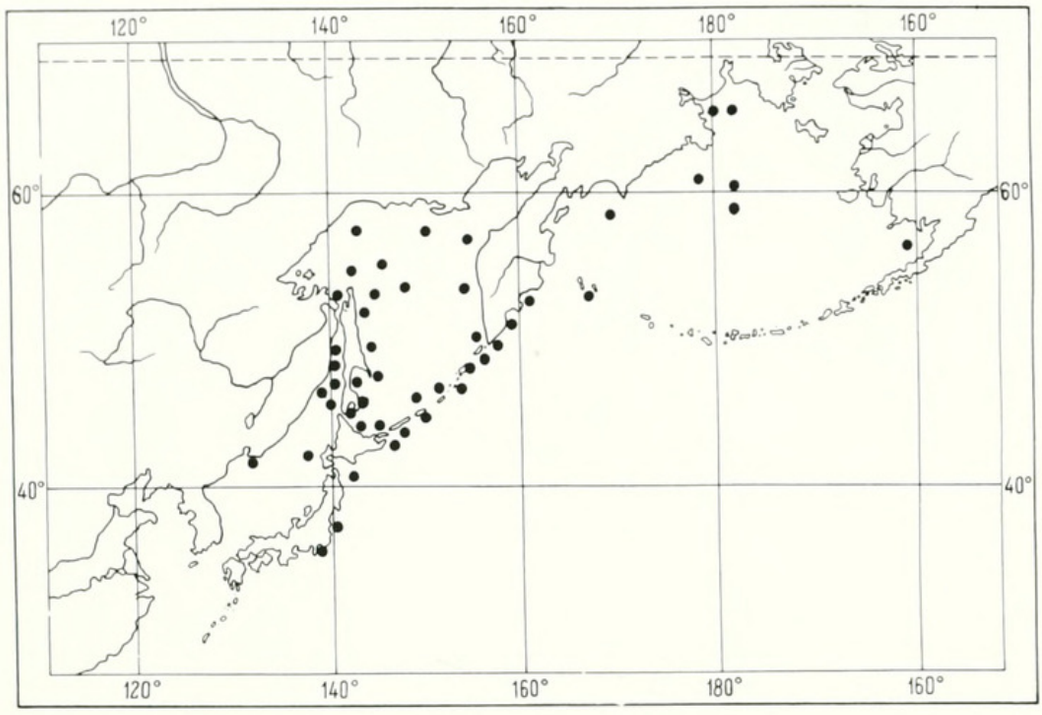


Figure 100. Geographic distribution of *Antiplanes sanctiioannis* (Smith, 1875).

Antiplanes yessoensis Dall, 1925:4, pl. 21, fig. 3.
Antiplanes (Rectiplanes) willetti Berry, 1953:419–420, pl. 29, fig. 2.
Antiplanes sadoensis Otuka, 1949:pl. 13, fig. 16 (*sensu auct.*, non Yokoyama, 1926).
Antiplanes thalaea Dall, 1919:37, pl. 11, fig. 6 (*sensu auct.*, non Dall, 1902:514).

Type specimens: Lectotype of *P. sanctiioannis* BM(NH) 1873.8.6.16, shell height 39.2 mm; paralectotypes BM(NH) 1873.8.6.16, shell height 39.9 mm, 23.2 mm. Type locality, about 100 miles south-eastward of Yesso [Hokkaido, Japan].

Lectotype of *P. beringi* (here designated), NRS N 1557, shell height 38.3 mm; paralectotypes NRS N 1557, 4 specimens. Type locality, 'Vega' Expedition, Bering Sea, 62°39′N, 177°05′W, 55 fms.

Holotype of *P. piona* USNM 109179, shell height 42 mm. Type locality, off S. coast of Kamchatka, 51°00′00″N, 157°48′00″E, in 96 fms, black sand, 'Albatross', sta. 3644 fms.

Holotype of *A. yessoensis* USNM 111053, shell height 39 mm. Type locality, Japan Sea, S. coast of Hokkaido, 41°58′00″N, 142°30′30″E, in 404 fms, brown mud, 'Albatross', sta. 5036.

Holotype of *A. willetti* CAS 064665, shell height 18.4 mm; paratypes—SBMNH No. 34539, and SDMNH 22856. Type locality, off Forrester Island, SW Alaska, 50 fms.

Material examined: Over 200 lots (about 700 specimens) were studied.

Description: Shell very variable, from elongate fusiform (figures 70, 77) to broadly fusiform (figures 81, 82), white with periostracum from light yellow to dark-brown. Body whorl variously convex. Relative height of body whorl varies within wide range (0.54–0.67). Whorls evenly rounded to angular at the shoulder and shell base, occasionally, below periphery of spire whorls (form described as *A. yessoensis*). Anal fasciole concave, flat, or convex. Anal sulcus form varies considerably, even within same specimen (figure 1). Spiral sculpture of numerous relatively narrow ribs, usually weaker at upper part of the whorl periphery and especially above anal fasciole. Ribs with serrated borders where crossed by growth lines, covered with secondary riblets that are usually inconspicuous or absent. Dendritic ribs moderately to highly developed only on anal fasciole, do not reach sutures on spire whorls. Siphonal canal usually recurved, varies from short, broad (figure 83) to long, narrow (figure 81). Shell height reaches 60 mm.

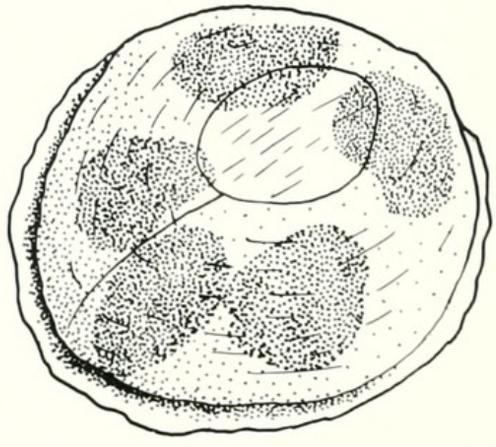


Figure 101. The egg capsule of *Antiplanes sanctiioannis* (Smith, 1875).

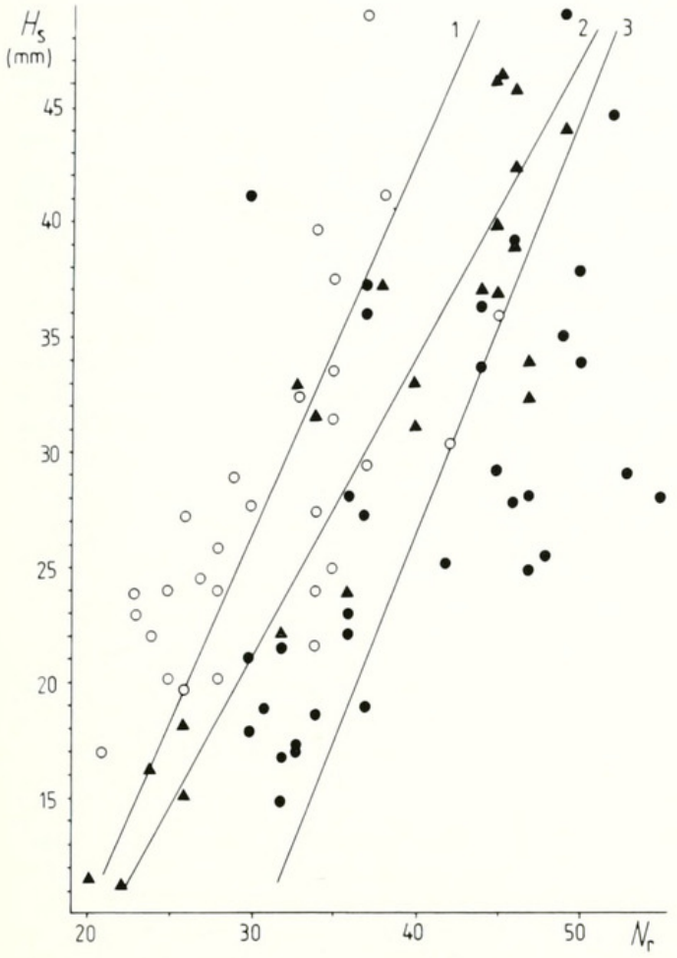


Figure 102. Comparison of the number of spiral ribs on the body whorl below the anal fasciole in populations of *Antiplanes sanctiioannis* (Smith). The shell height along the abscissa, the number of spiral ribs along the ordinate. Sakhalin Bay (open circles, 1—line of regression), east Sakhalin (solid triangles, 2—line of regression), and Tatar Strait (solid circles, 3—line of regression).

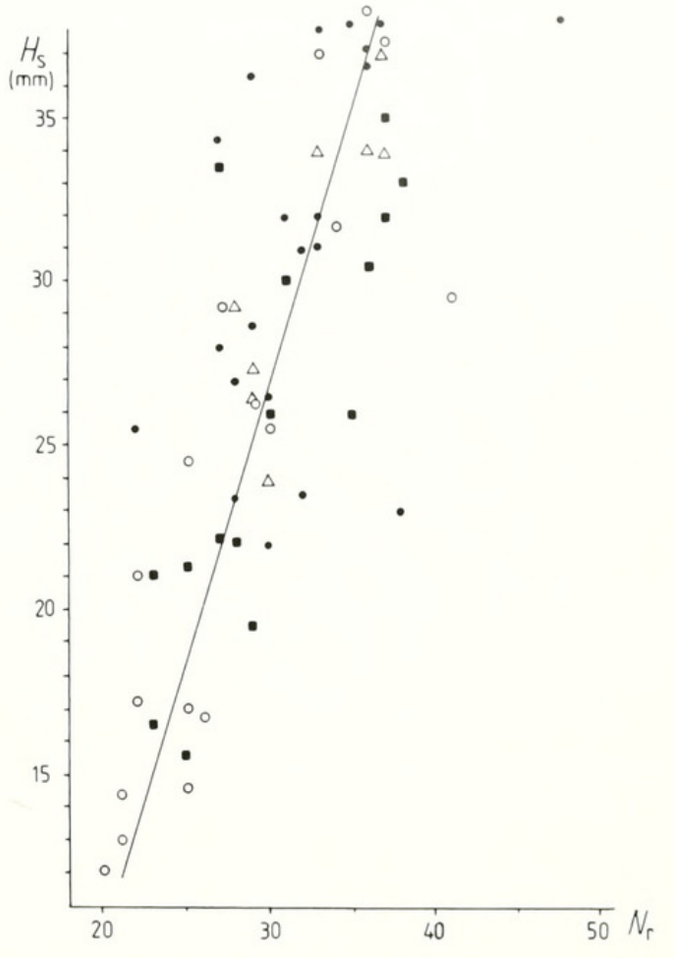


Figure 103. Comparison of the number of spiral ribs on the body whorl below the anal fasciole in populations of *Antiplanes sanctiioannis* (Smith). The shell height along the abscissa, the number of spiral ribs along the ordinate. Southern Kurile Island (solid squares), northern Kurile (solid circles), east Kamchatka (open circles), and Bristol Bay (open triangles).

Radula relatively large, ratio between shell height and mean marginal tooth length ranging from 85.4 (shell height 20.3 mm) to 173.4 (shell height 35.9 mm) (figure 18). Length of marginal teeth increases rapidly during ontogeny. Relationship between marginal tooth length and shell height nearly linear, expressed by regression equation:

$$Y = 0.1401 + 0.0030X$$

Egg capsules, most containing eggs, attached to shells of living *A. sanctiioannis*. Capsules were hemispherical (diameter—3 mm), with narrow flange at base. Surface covered with minute concentric creases, containing translucent, nearly circular apical plug (diameter—1 mm) (figure 101). Three capsules studied each contained up to 6 developing embryos.

Remarks: Shell morphology of this species is highly variable. The spiral ribs above the anal fasciole are usually absent, but may be poorly to well developed. Sculpture on the anal fasciole may consist of broad low ribs or very thin threads that may become obscure when dendritic ribs are well developed. The dendritic ribs are moderately to highly developed only on the anal fasciole and do not reach the sutures of the spire whorls. Spiral ribs become stronger, more widely spaced and usually broader below the anal fasciole. The number of ribs below the fasciole varies (3–12, usually 6–8, on the penultimate whorl) within populations and during ontogeny. When secondary riblets are well developed, the primary ribs tend to be low and uneven. Only a single specimen from the Bering Sea had uniform, equally developed ribs over the entire shell surface (figures 86, 87), and we refer this specimen to *A. sanctiioannis* with some doubt.

Although *A. sanctiioannis* is highly variable, different suites of morphological characters predominate in different portions of the species range. Among populations from the vicinity of Sakhalin Island, those in the Tatar Strait and adjacent waters have shells with dark coloration and distinct spiral sculpture that is more or less uniformly developed over the entire shell surface but that weakens slightly towards the suture (figures 70–73). Dendritic ribs are well-developed in most specimens from this area, but may be weak or limited to certain portions

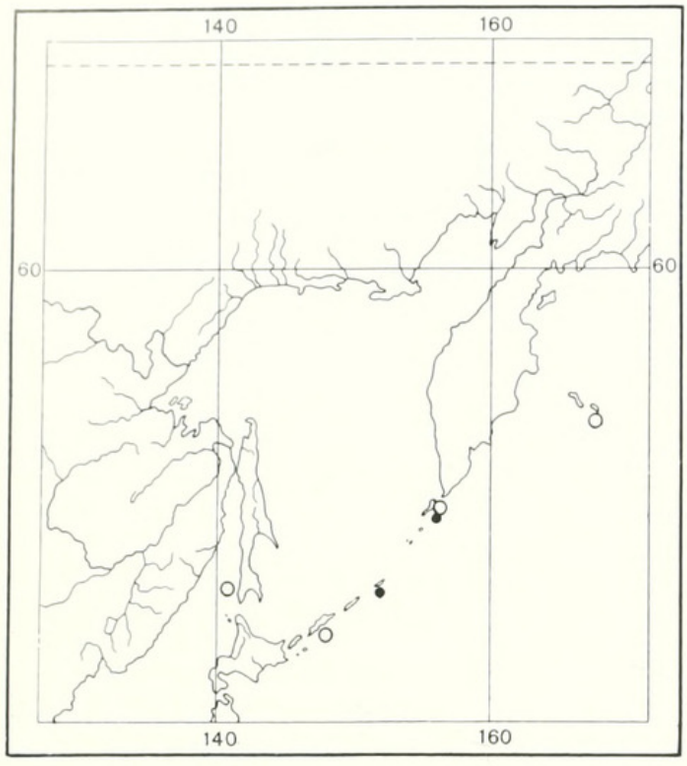


Figure 104. Geographic distribution of *Antiplanes kurilensis* n. sp. (open circles) and *A. spirinae* n. sp. (solid circles).

of the shell. Whorls are evenly rounded. The anal fasciole is flat or rarely concave. Numerous spiral ribs distinguish this population.

Specimens from Sakhalin Bay (northwestern Sakhalin) tend to be relatively light in color, and often have a convex anal fasciole and inconspicuous sculpture of fewer spiral ribs (figure 74). Spiral ribs weaken towards the periphery and dendritic ribs are usually well developed.

Intermediate forms occur along the eastern coast of Sakhalin and in the adjacent waters of the Okhotsk Sea. Specimens with angular shoulders and shell bases (figure 80) appear to be restricted to this region. Only there and, rarely, in the central and northeastern parts of the Okhotsk Sea do broadly fusiform shells with abruptly narrowing siphonal canals occur (figures 81, 82).

When these populations are compared on the basis of a quantitative character (number of spiral ribs below the anal fasciole of the last whorl), the population from the Tatar Strait (figure 102, black dots) overlaps little with the population from Sakhalin Bay. However, specimens from eastern Sakhalin occupy an intermediate position, suggesting clinal variation. Specimens found along the Kurile Islands usually have pronounced spiral sculpture over the entire shell surface, including the anal fasciole. Dendritic ribs are generally absent in these populations. Color is light yellowish to yellowish brown. Specimens with very shallow sinuses were found only near the Kurile Islands (figure 1 top, left). Specimens from the Kurile Islands, Sakhalin Bay, eastern Kamchatka, and the Bering Sea have a similar number of the ribs on the body whorl (figure 103).

Antiplanes sanctiioannis differs from *A. obliquiplicata* n. sp., *A. dendritoplicata* n. sp., *A. abyssalis* n. sp., and *A. kawamurai* in having well developed spiral sculpture that is always present below the anal fasciole of the spire whorls. *Antiplanes kurilensis* n. sp. can be distinguished from *A. sanctiioannis* by its higher spire (body whorl height/shell height ratio in *A. sanctiioannis* ranges from 0.542 to 0.667, mean value = 0.615 ± 0.004, while in *A. kurilensis* it varies from 0.500 to 0.533, mean value = 0.515 ± 0.005) and less elongate shell (shell diameter/shell height ratio for *A. kurilensis* ranges from 0.310 to 0.380, mean value = 0.346 ± 0.008, while in *A. sanctiioannis* it varies between 0.360 and 0.477, with a mean value of 0.420 ± 0.003). Features that distinguish *A. sanctiioannis* from *A. spirinae* n. sp. include the presence of spiral ribs with secondary riblets, as well as proportionally longer marginal teeth, which are evident when comparing equal-sized specimens (figure 18).

Antiplanes sanctiioannis differs from *A. isaotakii*, *A. motojimai*, and *A. habei* n. sp. in having more numerous spiral ribs (figure 138), and ontogenetically more slowly elongating marginal teeth.

Distribution: This widespread boreal species ranges from Sagami Bay (Honshu) to the Gulf of Anadyr in the northwestern Bering Sea, and has also been collected in the Sea of Japan and the Sea of Okhotsk. The bathymetric range of this species extends from 50 m (southern Sakhalin) to 1,530 m (southern Kurile Islands). Most specimens are from depths of 100 to 300 m (figure 100).

Antiplanes kurilensis new species
(figures 6, 89–93, 104)

Material examined: Holotype (ZM N Lc 6903): R/V 'Gydrobiolog' Iturup Island (Kurile Islands), depth 55–125 m, 1982; paratypes: R/V 'Gydrobiolog', Kurile Islands, 1982 (1 shell—ZM N Lc 6904); R/V 'Lebed', sta. 111, E off Shumshu, northern Kurile Islands, 50°46.9′N, 157°13.4′E, depth 103–104 m, muddy sand, 22.VII.1954 (1 specimen—ZIN N 1/54583); R/V 'Vityaz', 5th cruise, sta. 529, off Medny Island, Commander Islands, Bering Sea, 54°25.0′N, 168°16.4′E, depth 110 m, Sigsbee trawl, 14.VIII.1950 (5 specimens—ZM N Lc 6907); Expedition of the Institute of Marine Biology of the USSR Academy of Sciences, sta. 42, off Moneron Island, Tatar Strait, 46°16.7′N, 141°10.6′E, depth 115 m, 30.VIII.1972 (1 subfossil specimen—ZIN N 2/54584).

Description of holotype: Shell elongate-fusiform, with very high spire consisting of 10 whorls. Surface of first 3 whorls eroded. Body whorl moderately convex, comprising 0.51 of shell height. Shell light-brown, covered with thin, smooth, partly eroded periostracum. Teleoconch whorls evenly convex, enlarge slowly. Suture shallowly impressed, nearly canaliculate. Incremental growth lines thin, distinct, producing finely rugose appearance on shell surface. Spiral sculpture of narrow, non-dendritic, slightly wavy cords, 25 between sutures on spire whorls, about 50 on body whorl below anal fasciole. Cords evenly developed over entire shell surface. Surface of cords with pronounced growth lines. Base of shell

weakly convex, gradually passing into short, straight, obliquely truncated siphonal canal. Aperture oval, narrow. Inner lip slightly curved, covered with very thin callus. Callus better developed on columella. Aperture comprises 0.35 of shell height.

Dimensions of holotype: Shell height 54.6 mm, body whorl height 27.7 mm, aperture height 19.2 mm, shell diameter 17.6 mm.

Remarks: Paratypes have less conspicuous spiral sculpture, especially on the upper part of the whorls, and less numerous spiral ribs below the anal fasciole of the body whorl (<40 in paratype with shell height of 52.3 mm). Weak dendritic threads may be present on or above the anal fasciole. Only a single specimen from off Shumshu Island had moderately developed dendritic threads on the anal fasciole.

The radula (figure 6) of a paratype (shell height 28.8 mm) was studied. Marginal teeth were 0.221 mm long (shell height/marginal tooth length = 130.3).

Antiplanes kurilensis is most closely related to *A. sanctiioannis*, but differs in having a higher spire (body whorl height/shell height = 0.500–0.533, mean value 0.515 ± 0.005 for *A. kurilensis*, 0.542–0.667, mean value 0.615 ± 0.004 for *A. sanctiioannis*).

Distribution: This species occurs in the northern and southern Kurile Islands and off Medny Island at 55–125 m. One subfossil specimen was found near Moneron Island (figure 104). A specimen resembling this new species conchologically was found in Pliocene deposits of north-eastern Honshu, and was referred to *Antiplanes* (*Rectiplanes*) *sadoensis* (Yokoyama) by Chinzei (1959:pl. X, figs. 6–7, not figs. 8–9).

Antiplanes spirinae new species
(figures 4, 22, 94–99, 104)

Material examined: Holotype (ZIN N 1/54585): R/V 'Lebed', sta. 122, off Shumshu Island, northern Kurile Islands, 50°32.5'N, 157°27'E, depth 280 m, sand, gravel 1.VIII.1954; paratypes: R/V 'Odyssey', 34th cruise, sta. 47, off Simushir, central Kurile Islands, 46°44.9'N, 155°21.0'E, depth 450–480 m, 30.XII.1984 (3 specimens—ZM N Lc 6905, shell heights 22.4; 16.3; 14.2 mm).

Description of holotype: Shell thin, high spired consisting of 9 preserved whorls. Two earliest whorls lost. Teleoconch whorls evenly rounded, weakly convex, widest below shoulder. Sutures shallow. Body whorl rather convex, comprising about ½ shell height. Coiling axis curved. Shell dark olivaceous; shell base, portions of anal fasciole lighter. Periostracum thin, finely granulated, peeling. Growth lines very thin, often darker than shell surface. Spiral sculpture on anal fasciole of 3–4 wide, unequal spiral cords somewhat broken by growth lines. Spiral cords less conspicuous toward body whorl. Dendritic threads stronger on anal fasciole, but generally much weaker than in other species of *Antiplanes*. Remaining surface of shell whorls covered by wide, flattened cords that become less conspicuous in later whorls, nearly absent on body whorl. Entire shell surface covered by microscopic secondary spiral threads, most conspicuously on shell base (figure 99). Shell base weakly convex, joining short siphonal canal, broken at tip. Aperture short, narrow, oval. Outer lip joining columella at acute angle. Parietal wall, columella covered by narrow, thin, white callus.

Dimensions of holotype: Shell height 36.5 mm, body whorl height 17.9 mm, aperture height 12.2 mm, shell diameter 12.0 mm.

Remarks: The paratypes have flatter whorls and less developed spiral cords on the shell surface and on the anal fasciole. The secondary threads are better developed and dendritic threads are practically absent in the paratypes.

Radulae of two paratypes were studied (figure 4). The mean length of the marginal teeth of the specimen with a shell length of 16.3 mm was 0.166 mm (shell height/marginal tooth length length = 98.2). The corresponding values for the 22.4 mm specimen are 0.169 mm and 132.5.

Antiplanes spirinae is most similar to *A. sanctiioannis*, but differs in having a narrower shell with a higher spire and less convex whorls, as well as spiral sculpture of poorly developed spiral cords and well developed secondary threads. The marginal teeth of *A. spirinae* are generally shorter than in *A. sanctiioannis* (figure 18, specimens from the same localities connected by a dotted line).

Etymology: This species is named in honor of Dr. N. Spirina, who collected the holotype.

Distribution: This species is known from the northern and central Kurile Islands at depths of 280–480 m (figure 104).

Antiplanes vinosa (Dall, 1874)
(figures 9, 10, 24, 29, 105–120)

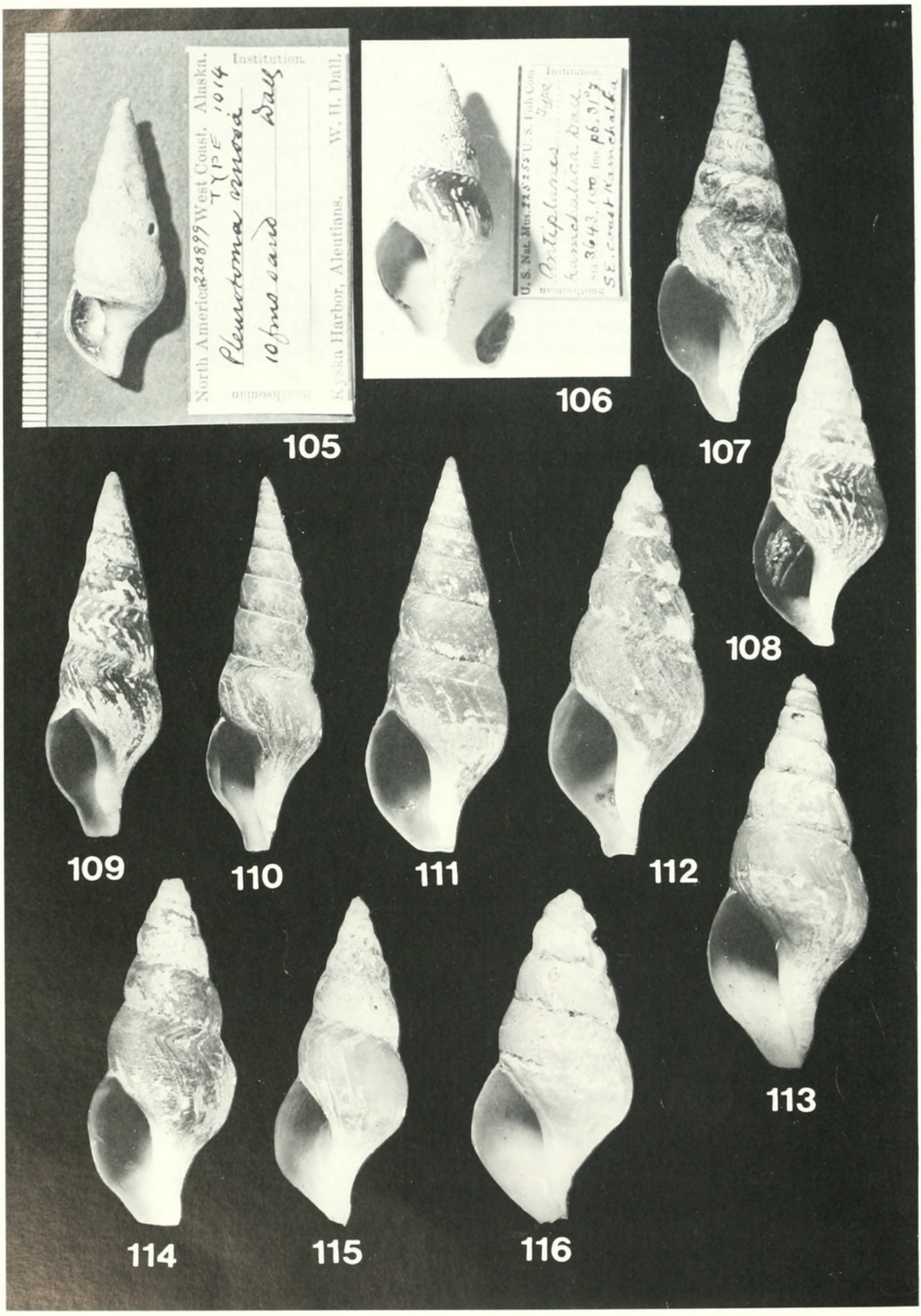
Pleurotoma vinosa Dall, 1874:553.
Pleurotoma (*Antiplanes*) *vinosa* Dall, 1902:514, pl. 34, fig. 4.
Antiplanes kamchatica Dall, 1919:33–34, pl. 10, fig. 1.
Antiplanes contraria Yokoyama, Kira, 1965:100, pl. 36, fig. 2.

Type specimens: Holotype of *Pleurotoma vinosa*, USNM 220899, shell height 36 mm. Type locality—Kyska Harbour, Great Kyska Island, Aleutian Islands, 10 fms.

Holotype of *Antiplanes kamchatica*, USNM 225255, shell height 52 mm. Type locality—south-eastern coast of Kamchatka, 100 fms.

Material examined: 40 samples (more than 150 specimens) were studied.

Description: Shell sinistral, variable, usually with high spire. Color dark-brown to light yellow. Body whorl comprises 0.53 to 0.61 of shell height. Shell axis often curved. Whorls weakly to moderately convex, evenly rounded. Growth lines inconspicuous. Spiral sculpture of numerous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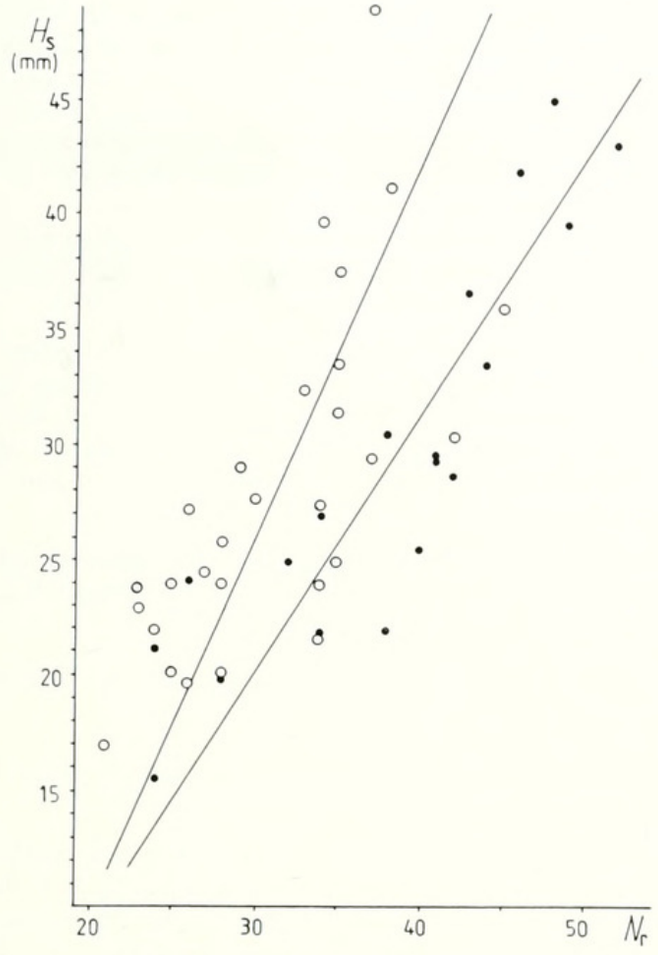


Figure 117. Comparison of the number of spiral ribs on the body whorl below the anal fasciole in Sakhalin Bay populations of *Antiplanes vinosa* (Dall) (solid circles, right regression line) and *A. sanctiioannis* (Smith) (open circles, left regression line). The shell height along the abscissa, the number of spiral ribs along the ordinate.

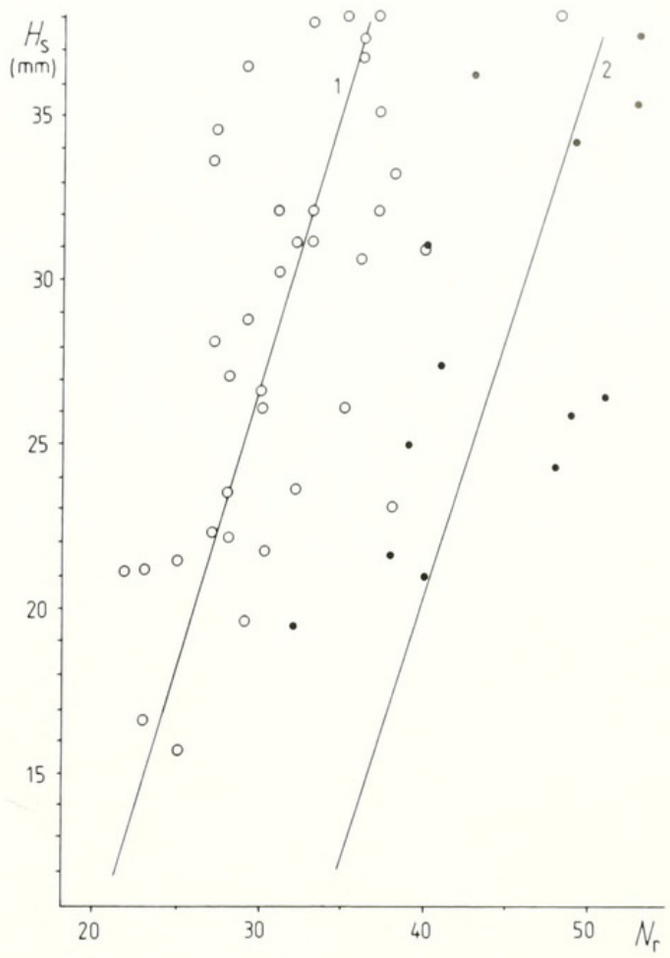


Figure 118. Comparison of the number of spiral ribs on the body whorl below the anal fasciole in the Kurile populations of *Antiplanes vinosa* (Dall) (solid circles, 2—line of regression) and *A. sanctiioannis* (Smith) (open circles, 1—line of regression). The shell height along the abscissa, the number of spiral ribs along the ordinate.

variably developed wavy spiral cords spanning shell surface, most pronounced on siphonal canal. Cords sometimes indistinct on and above anal fasciole. Dendritic threads variable in development, usually present on the anal fasciole, but not reaching suture on spire whorls. Aperture narrow, oval, usually well-differentiated from long, straight siphonal canal.

Radula medium sized for genus, shell height/mean marginal tooth length varies from 111.6 (shell height 21.2 mm) to 158.4 (shell height 48.8 mm). Increase in marginal tooth length with shell growth similar to that of *A. sanctiioannis*; regression equation: $Y = 0.0942 + 0.0043X$ (figure 18).

Remarks: *Antiplanes vinosa* is the only sinistral species of *Antiplanes* in the northwestern Pacific Ocean. *Antiplanes sanctiioannis* is the most closely related dextral species. The number of spiral cords below the anal fasciole on the body whorl of *A. vinosa* is greater than in *A. sanctiioannis* (figure 117). Moreover, the spire of *A. vinosa* is generally higher than that of *A. sanctiioannis*, even in sympatric specimens (figure 119). In Sakhalin Bay, the ratio body whorl height/shell height is 0.57–0.62 (mean 0.589 ± 0.006) for *A. sanctiioannis*, and 0.53–0.57 (mean 0.553 ± 0.006) for *A. vinosa*. Regression equations are $Y = 0.5852 - 0.0007X$ and $Y = 0.6346 -$

←

Figures 105–116. Shells of *Antiplanes vinosa* (Dall, 1874). **105.** Holotype of *Pleurotoma vinosa* Dall, 1874, USNM 220899, 36 mm. **106.** Holotype of *Antiplanes kamchatica* Dall, 1919, USNM 925255, 52 mm. **107.** Sakhalin Bay, Okhotsk Sea, 45.2 mm. **108.** Tatar Strait, 28.5 mm. **109.** Central Kurile Islands, 51.7 mm. **110.** Off Moneron Island, Tatar Strait, 42.0 mm. **111.** Off Paramushir, northern Kurile Islands, 46.5 mm. **112.** Northern Okhotsk Sea, 53.7 mm. **113.** Off Shikotan, southern Kurile Islands, 40.9 mm. **114.** Eastern Kamchatka, 35.3 mm. **115.** Off Onekotan Island, central Kurile Islands, 29.7 mm. **116.** Southern Kurile Islands, 31.3 mm.

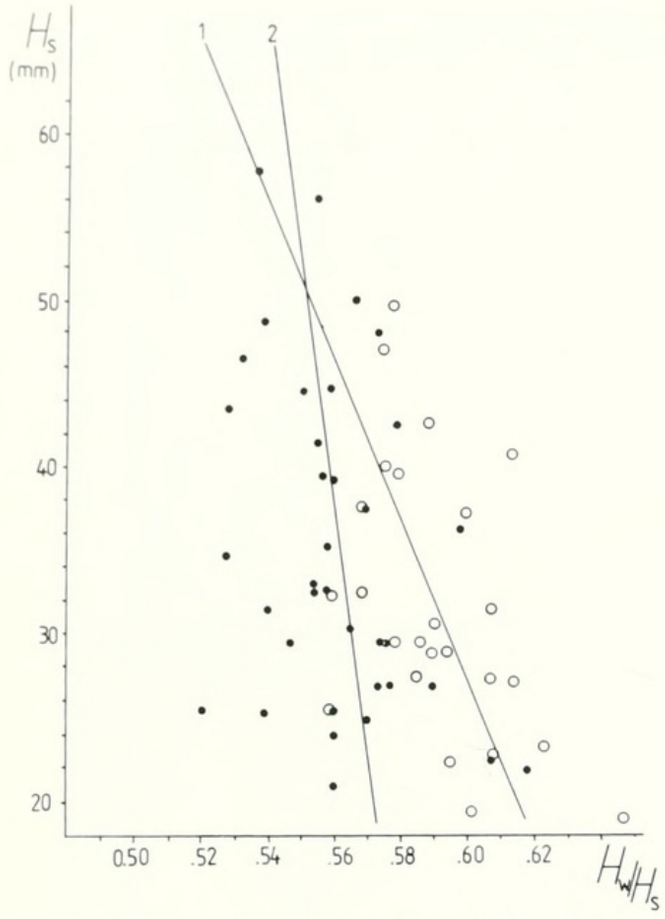


Figure 119. Comparison of the relative height of the body whorl of *Antiplanes vinosa* (Dall) (solid circles, 2—line of regression) and *A. sanctiioannis* (Smith) (open circles, 1—line of regression). The shell height along the abscissa, the ratio between the body whorl height and the shell height along the ordinate.

0.0013X respectively, where Y is the ratio of body whorl height to shell height and X is the shell height.

Distribution: *Antiplanes vinosa* was recorded from the northeastern part of Honshu (Kira, 1965), the northern Japan Sea to the northern Okhotsk Sea, and from the Bering Sea (figure 120).

Antiplanes isaotakii (Habe, 1958)
(figures 5, 121, 123–125, 137, 138)

Rectiplanes (Rectisulcus) isaotakii Habe, 1958:182, 185–186, text. fig. 2; Okutani 1964:424.

Type specimens: Holotype, NSMT 38591, shell height 28.5 mm; paratype, NSMT 52684. Type locality, of Choshi, Chiba Pref., Honshu.

Material examined: Off Kurile Islands (1 specimen); off southern Kurile Islands (1 specimen).

Description: Shell light-olivaceous, elongate, high spired. Body whorl weakly convex, comprising 0.57–0.62 shell height. Spire whorls weakly to moderately convex, slightly angulated at periphery, flattened at anal fasciole. Suture shallow. Siphonal canal long, slightly curved. Aperture narrow, short, comprising 0.44–0.52 of shell height. Outer lip joining columella at nearly right angle. Spiral sculpture well developed, comprised of 2–3 flattened to convex cords between suture and anal fasciole, ≤5 cords on fasciole, sometimes with traces of dendritic threads, 20 wide, rounded cords, uniformly developed over entire body whorl below anal fasciole. Earlier whorls with 4–5 cords below anal fasciole.

Radula of 30.8 mm specimen was studied (figure 5). Marginal teeth were large (mean length = 0.289 mm, shell height/tooth length ratio = 106.6) (figure 18).

Remarks: *Antiplanes isaotakii* is conchologically similar to some forms of *A. sanctiioannis*, but differs in having longer marginal teeth and fewer spiral cords that are more convex, wider, and more evenly spaced. It differs from *A. habei* in having fewer spiral cords and a more acutely angled periphery.

Distribution: *Antiplanes isaotakii* was recorded off Chiosi, Honshu, in Sagami-Bay and off the southern Kurile Islands in 200–780 m (figure 137).

Antiplanes motojimai motojimai (Habe, 1958)
(figures 122, 137)

Rectiplanes (Rectisulcus) motojimai Habe, 1958:182–185, fig. 3; Okutani, 1964:424, pl. 4, fig. 7.

Type specimens: Holotype, NSMT 30600, shell height 38.2 mm; paratypes, NSMT 30600a–b, shell heights 37.0, 35.5 mm. Type locality—off Chiosi, Chiba Prefecture, Honshu, Japan.

Description: "Shell elongate with about eight whorls which are moderately inflated but deeply constricted at the suture, covered with the olivaceous periostracum; surface sculptured with the spiral cords, two or three of which are contained in the area between the rather broad fasciole and the upper suture and also two or three in the area between the fasciole and the lower suture; body whorl very large and stout, occupying about two-thirds of the shell length, the periphery of which is rounded and the base is marked by the spiral cords all over; aperture wide, the outer margin broadly sinuated in V-shape at a little above the periphery; canal broad and short; columellar margin white." (Habe, 1958:184).

Remarks: This species is most similar to *A. isaotakii*, but differs in having a broader shell and fewer spiral cords (21 cords below the anal fasciole on the body whorl of the holotype) that become narrower towards the siphonal canal.

Distribution: This subspecies occurs from Sagami Bay to the Sea of Kashima Nada (eastern Honshu), in 550–870 m (Okutani, 1964). It is not represented in collections of USSR institutions.

Antiplanes motojimai aquilonalis new subspecies
(figures 126, 127, 137)

Material examined: Holotype (ZM N Lc 6906): R/V 'Adler', 18th cruise, sta. 169, eastern Bering Sea, 62°59'N,

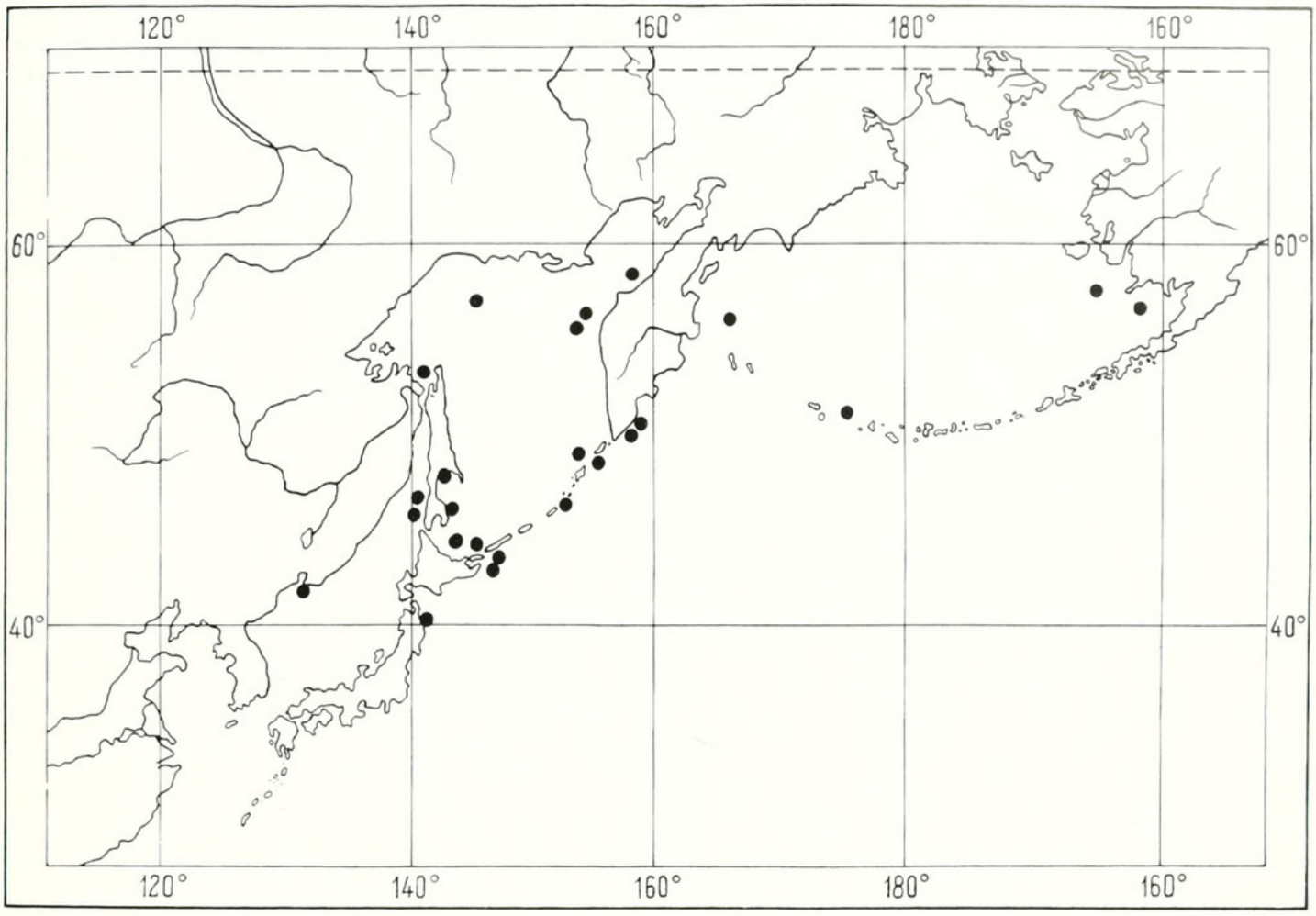


Figure 120. Geographic distribution of *Antiplanes vinosa* (Dall).

171°05′W, depth 46 m, 1983; paratypes: R/V 'Vityaz', 2nd cruise, sta. 20, southern Okhotsk Sea, 45°01.1′N, 144°21.0′E, depth 429–404 m, muddy sand and gravel, 10.VIII.1949 (empty shell—ZM N Lc 6908); R/V 'Akademik Oparin', 7th cruise, sta. 17, north-eastern Okhotsk Sea, 56°00′N, 146°29′E, depth 397 m, 1988 (empty shell—ZIN N 1/54624).

Description of holotype: Shell broad, consisting of 6 whorls, with earliest 1.5 whorls lost, next 3 whorls eroded. Spire whorls evenly convex, with narrow, flattened subsutural band above anal fasciole. Suture deeply impressed. Shell color dark olive. Periostracum thick, glossy. Growth lines numerous, some raised, rough, forming raised flat tubercles along lower parts of whorls. Spiral sculpture well developed, with 4–5 distinct, flattened ribs below anal fasciole on spire whorls. Body whorl with two narrow cords adjacent to anal fasciole, next 4 cords 1.5 times as broad, remaining 10 cords becoming progressively narrower towards siphonal canal. Cords flat, with serrated borders at intersections with growth lines. Anal fasciole with 2–3 thin threads, separated by wide interspaces. Dendritic threads well developed, reaching suture on spire whorls, disappearing on shell base. Anal fasciole with very thin secondary threads, especially on spire whorls. Siphonal canal broken. Shell base eroded. Aperture narrow, oval.

Dimensions of holotype: Shell height 35.5 mm, body whorl height 21.6 mm, aperture height 14.2 mm, shell diameter 16.5 mm.

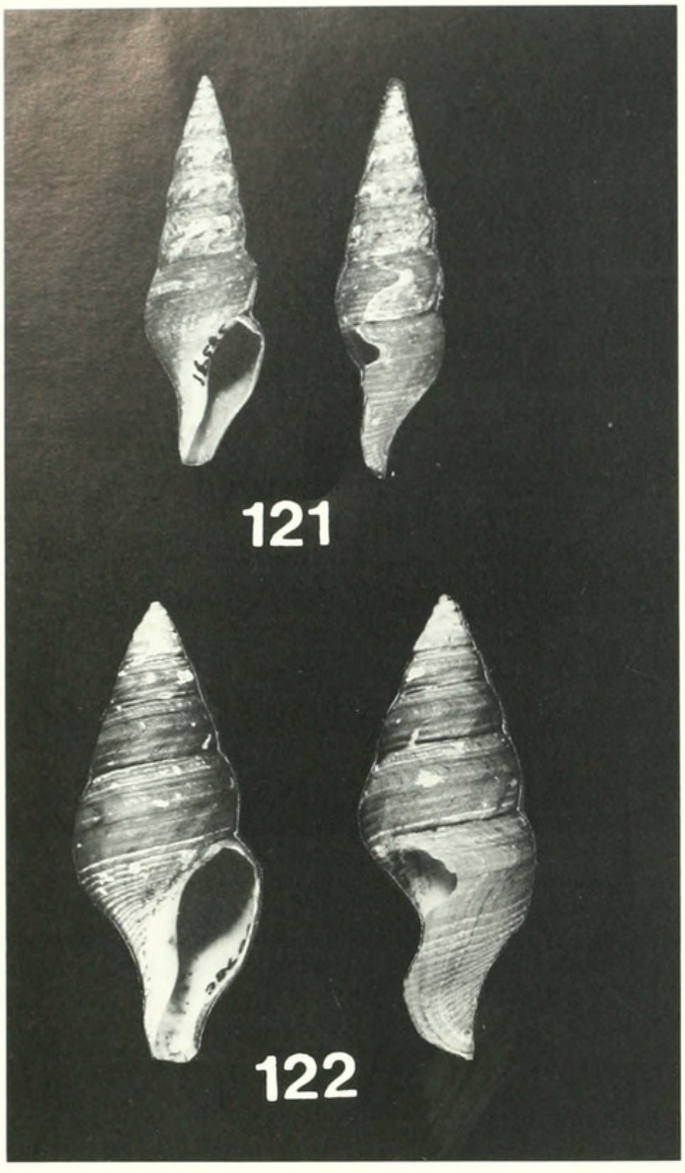
Remarks: Paratypes are very similar to the holotype, but differ in having three ribs above the anal fasciole. This new subspecies differs from the nominatypical one in spiral sculpture: while *Antiplanes motojimai motojimai* has equally developed cords on the periphery of the whorls and on the anal fasciole, *Antiplanes motojimai aquilonalis* lacks wide ribs on the fasciole. These two subspecies differ in their geographical distributions.

Distribution: This new subspecies was recorded in the Okhotsk and Bering Seas at depths from 46 m (Bering Sea) to 550 m (southern Okhotsk Sea) (Fig. 137).

Etymology: *aquilonalis* Latin—northern, from *Aquilo* Latin—northern wind.

Antiplanes habei new species
(figures 7, 8, 23, 128–135, 137, 138)

Material examined: Holotype (ZM N Lc 6909): R/V 'Vityaz', second cruise, sta. 100, central part of the Okhotsk



Figures 121, 122. Shells of *Antiplanes* spp. **121.** *Rectiplanes isaotakii* Habe, 1958, holotype, NSMT N 52684, 28.5 mm. **122.** *Rectiplanes* (*Rectisulcus*) *motojimai* Habe, 1958, holotype, NSMT N 38600, 38.2 mm.

Sea, 54°35.0′N, 149°49.5′E, depth 543 m; paratypes: R/V 'Vityaz', 12th cruise, sta. 1853, central part of the Okhotsk Sea, 55°38.5′N, 143°01.0′E, depth 389 m, mud (1 specimen—ZM N Lc 6910); R/V 'Adler', 18th cruise, sta. 42, Okhotsk Sea, 49°12.7′N, 144°57.6′E, depth 245–260 m (1 specimen—ZM N Lc 6911); R/V 'Gagara', sta. 217, Okhotsk Sea, 51°35′N, 154°46′E, depth 410 m, (1 specimen—ZIN N 3/54625); R/V 'Gagara', sta. 252, Okhotsk Sea, 55°32.4′N, 149°14′E, depth 335 m (3 specimens—ZIN N 2/54626); R/V 'Toporok', sta. 17, off Shikotan, 43°32.5′N, 147°20.5′E, depth 1,450–1,530 m (2 specimens—ZIN N 1/54627).

Description of holotype: Shell elongate-fusiform, with high spire and high, weakly convex body whorl that comprises 0.57 of shell height. Shell of seven whorls, with at least one upper whorl lost. First preserved whorl eroded. Shell yellowish, with darker spiral band below anal fasciole. Periostracum thin, glossy. Whorls weakly convex, with flattened periphery nearly parallel to shell axis. Sutures impressed, shallow. Incremental growth striae thin, inconspicuous, some marked by color. Spiral sculpture of inconspicuous dendritic thread-like riblets on anal fasciole (4–5 on penultimate whorl, 3 on body whorl) reaching sutures on spire whorls and disappearing at periphery of body whorl. Ribs, 2–3 above fasciole, 4–5 below fasciole on three upper whorls, up to 9 on other spire whorls, 31 below fasciole on body whorl, becoming more distinct toward siphonal canal. Five ribs below anal fasciole flattened and of equal width, subsequent ribs more narrow and raised. Shell base flattened, joining short siphonal canal with distinct bend. Aperture narrow, short, comprising 0.43 of shell height. Outer lip joins columella at obtuse angle. Callus thin, narrow, white, glossy, covers columella and parietal wall. Siphonal canal poorly differentiated from aperture.

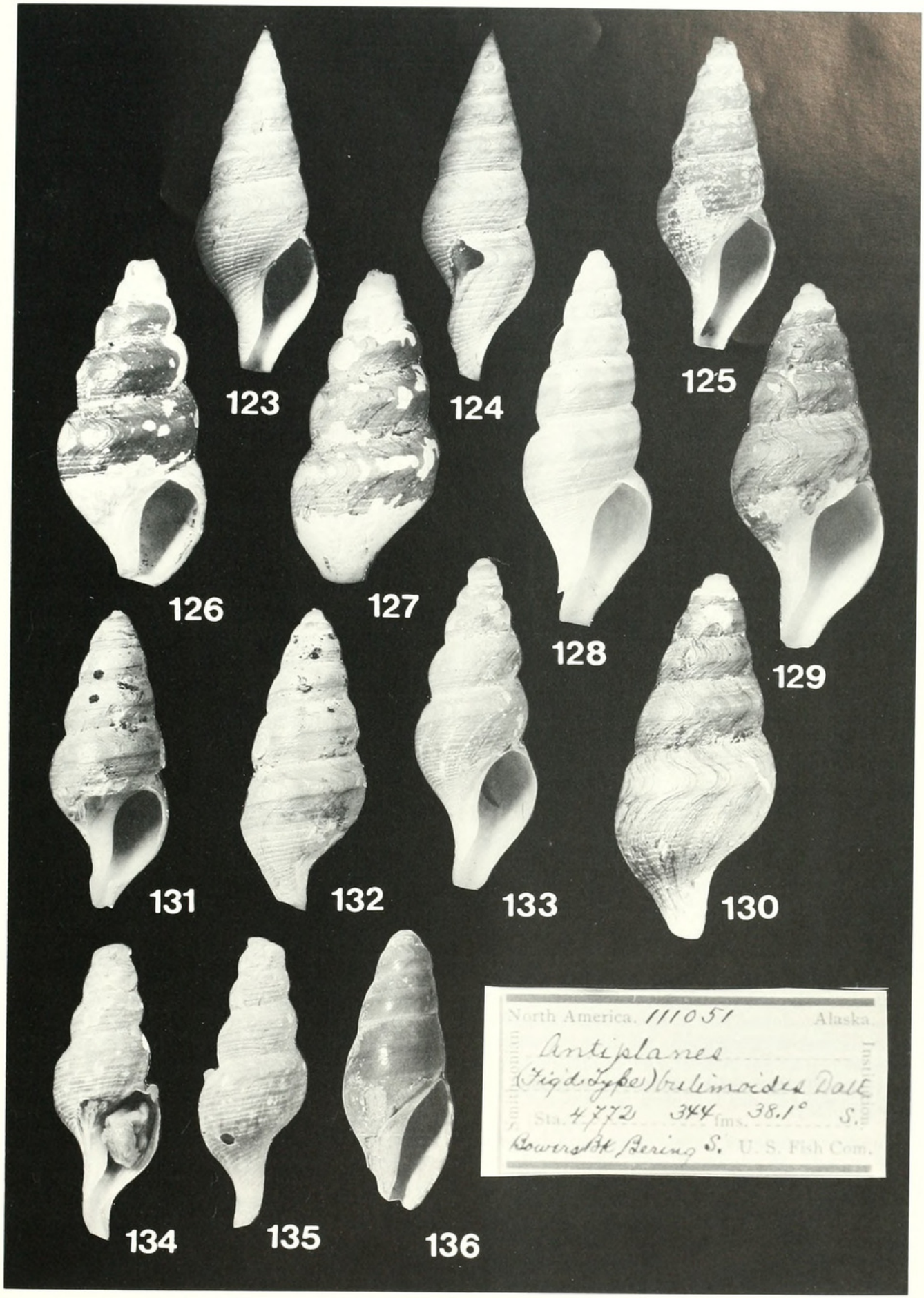
Dimensions: Holotype, shell height 38.0 mm, body whorl height 21.6 mm, aperture height is 16.3 mm, diameter 13.6 mm.

Remarks: Paratypes have slightly more convex and rounded whorls, wider apertures, more distinct spiral ribs below the anal fasciole, and wide, flat ribs on the fasciole that are absent on the body whorl. Limited material does not allow an evaluation of the range of intraspecific variability. We provisionally refer to this species two specimens from off Shikotan that differ from other paratypes in having: rounded or angulated, but never flattened whorls, a longer siphonal canal, high anal sinus apex, different geographic (southern Kuriles rather than the Okhotsk Sea) and bathymetric (1,450–1,530 m vs. 335–575 m) distributions.

The radulae of four specimens were studied (figures 7, 8). The marginal teeth are large; the ratio between the shell height and the tooth length varies from 76.3 (the shell height 14.2 mm) to 118.9 (37.8 mm). Their length rapidly increases with shell growth according to the regression equation:

→

Figures 123–136. Shells of *Antiplanes* spp. **123–125.** *Antiplanes isaotakii* (Habe, 1958). **123, 124.** ? Kurile Islands, 31.0 mm. **125.** Southern Kurile Islands, 24.3 mm. **126, 127.** *Antiplanes motojimai aquilonalis* n. subsp. holotype, ZM N Lc 6906, 35.5 mm. **128–135.** *Antiplanes habei* n. sp. **128.** Holotype, ZM N Lc 6909, 38.0 mm. **129, 130.** Paratype, Okhotsk Sea, ZM N Lc 6911, 29.0 mm. **131, 132.** Central part of Okhotsk Sea, ZM N Lc 6910, 23.0 mm. **133–135.** Off Shikotan, Kurile Islands, ZIN N 1/54627 (133—33.5 mm, 134, 135—23.2 mm). **136.** *Antiplanes bulimoides* Dall, 1919. Holotype, 31 mm.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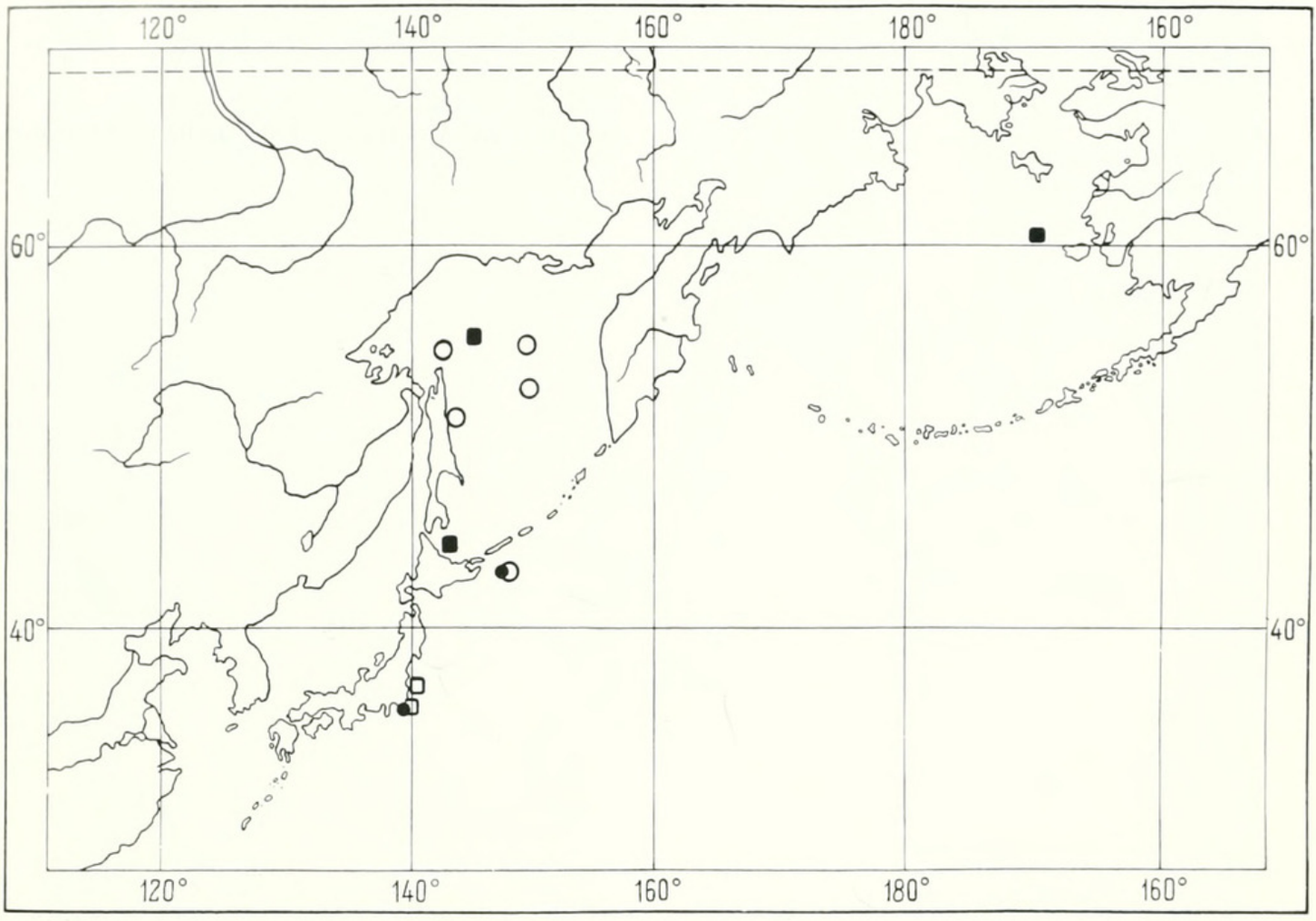

Figure 137. Geographic distribution of *Antiplanes isaotakii* (Habe) (solid circles), *A. motojimai motojimai* (Habe) (open circles), *A. motojimai aquilonalis* n. subsp. (solid squares), and *A. habei* n. sp. (open circles).

$$Y = 0.1290 + 0.0052X.$$

Antiplanes habei is most similar to *A. sanctiioannis*, but differs in having more convex, wider and less numerous ribs (figure 138) that are nearly equal over the body whorl. The ribs of *A. sanctiioannis* are considerably more pronounced on the shell base and the siphonal canal. This new species has large marginal teeth (figure 18), which is most clearly seen when comparing equal-sized specimens from the same locality (the respective points are connected by dotted line in figure 18). *Antiplanes habei* also resembles *A. isaotakii*, but differs from it in having a deeper suture, more convex whorls, more numerous ribs on the body whorl, as well as in lacking the angular periphery.

Distribution: *Antiplanes habei* was recorded in the Okhotsk Sea and the southern Kurile Islands at depths from 335 m (central part of the Okhotsk Sea) to 1,530 m (off Shikotan) (figure 137).

Etymology: This new species is named in honor of Dr. Tadashige Habe, who has considerably widened our knowledge of the north-western Pacific species of *Antiplanes*.

Antiplanes bulimoides Dall, 1919
(figure 136)

Dall, 1919:34, pl. 11, fig. 7; Dall, 1925:4, pl. 31, fig. 2.

Material examined: Holotype (USNM 111051), U.S. Bureau of Fisheries, Station 4772 on Bowers Bank, Bering Sea, 54°30′30″N, 179°13′00″E, in 344 fathoms, green-brown sand, bottom temperature 38.1°F, 6.IV.1906.

Description: "Shell elongate, decollate. Whorls six or more, four remaining. Suture distinct, not appressed. Whorls moderately convex, smooth, with pale polished greenish periostracum, in spots minutely granulose, apparently from some wrinkling of the periostracum. Anal sulcus wide, shallow, barely forming a fasciole. Outer lip thin, sharp, moderately produced. Inner lip with a thin white layer of callus. Columella straight, with an oblique anterior attenuation. Canal wide, hardly differentiated. Length of three complete whorls, 31 mm. Length of last whorl, 23 mm. Diameter at apex, 5 mm. Maximum shell diameter, 15 mm."

Remarks: So far as we know, this species is known only from the holotype, which is figured and described here.

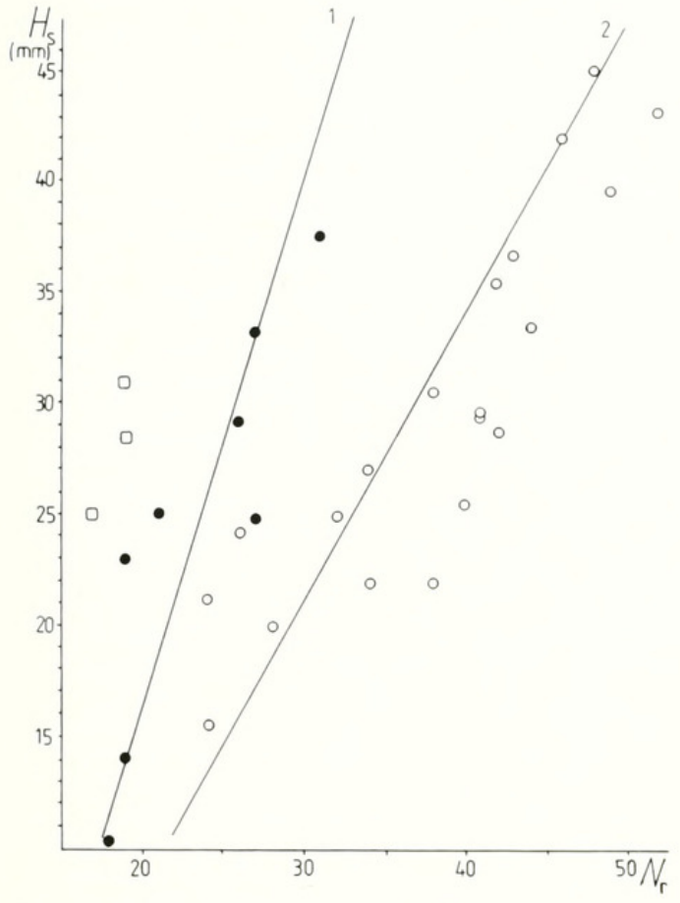

Figure 138. Comparison of the number of spiral ribs on the body whorl below the anal fasciole in populations of *Antiplanes isaotakii* (Habe) (open squares), *A. habei* n. sp. (solid circles, 1—line of regression), and *A. sanctiioannis* (Smith) (open circles, 2—line of regression). The shell height along the abscissa, the number of spiral ribs along the ordinate.

The bulimoid shape and glistening greenish periostracum makes this species quite unique.

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