specimen is therefore assigned to *L. tridentatus;* it is the southernmost record for the genus in the South China Sea and is an isolated locality for this species.

GEOGRAPHIC DISTRIBUTION: Western Pacific: South-eastern and western Japan, South China Sea near Hong Kong, central and south-eastern coast of Australia; Fiji; New Caledonia; northern New Zealand. Central Pacific Ocean: Hawaii. Eastern Indian Ocean: South-western coast of Australia.

BATHYMETRIC DISTRIBUTION: Continental shelf and slope from 15 to 210 fms.

Lyreidus brevifrons Sakai, Figs. 1; 6b, g, f; 7c, d; 8c. Pl. 1B.

Lyreidus brevifrons Sakai, 1937: 171, text-figs. 38b, 41b, 42a, b, pl. 16 fig. 6 (type locality: Mimase, Tosa Bay, Japan; type probably not extant—T. Sakai, pers. comm.); 1965: 6, pl. 2 fig. 4.

Lyreidus tridentatus; Doflein, 1904: 52.
(non) *Lyreidus tridentatus* De Haan, 1841.

LOCALITIES PREVIOUSLY REPORTED: Japan: Tosa Bay (Sakai, 1937). Amadaiba, Aoyama-dshi and west of Jogashima, Sagami Bay, 65–80 m. (Sakai, 1965).

Western Indian Ocean: Off Dar-es-Salaam, 400 m., "Valdivia" Sta. 242 (Doflein, 1904—as *Lyreidus tridentatus*).

MATERIAL EXAMINED: A total of six specimens, as follows: Japan: Off Honshu, 5/5/1900, "Albatross" Sta. 3698, 1 ♂, 32.2mm (USNM 57687).

South China Sea: S.E. of Hainan, 16°20'N., 114°39' to 114°39.5'E., 216–214 fms, fine calcerous sand, Agassiz trawl, 15/8/1965, FHK Sta. 57, 2 ♂♂, 26.7, 33.5mm, 1 ♀ (fragments) (AM P.15781). S. of Hainan, 16°47.5'N., 109°49.5'E to 16°45'N., 109°52'E., 200–290 fms, find mud, Agassiz trawl, 5/3/1965, FHK Sta. 17, 2 ♂♂ (1 with sacculina), 28.9, 30.5mm (AM P.15782).

Western Indian Ocean: Off Dar-es-Salaam, 400 m., "Valdivia" Sta. 242, 1 ♂, 31.3mm (ZMB 13656—photographs and drawings only).

REMARKS: Sakai (1937) listed nine features in which *L. brevifrons* differed from *L. tridentatus.*

1. "The spine on the anterolateral borders is more prominent and curved forward at the tip." This feature provides a difference from most adults of *L. tridentatus* but some large specimens of that species have the lateral spines forwardly curved and small specimens often do.

2. "The carapace is markedly constricted immediately behind the external orbital spines." In *L. brevifrons* the anterior part of the anterolateral borders of the carapace are parallel, rather than convergent posteriorly; this feature is found only in very small *L. tridentatus*—in large specimens of the latter these borders are markedly divergent even anteriorly.

3. "The external orbital spines are much more prominent . . . they are very slender and parallel . . . and project outwards at the tips; the lower edge . . . is not concave and not angled below the eyes." These features are a corollary for 2 above and provide a similarly good distinction between the two species.

4. "The tip of the second antenna projects far beyond the tip of the external orbital spine, while in *L. tridentatus* the former falls much short of the latter." Sakai presumably meant the basal article of the second antenna and his sentence should be changed by substituting *L. brevifrons* for *L. tridentatus* (see Sakai, 1937: figs. 38a and b) but the distinction is difficult to make.

5. "The tips of the external orbital spines project beyond the tip of the rostrum, the distance between both spines being more than one-third the extreme width of the carapace." The narrowness of the carapace anteriorly in *L. brevifrons* is a reliable distinction from *L. tridentatus,* despite changes with growth, but the length of the external orbital spines does not appear to be—in both species the tip of the rostrum is almost on the same level as the tips of the external orbital spines and the differences are small. However, the rostrum and the external orbital spines are more slender in *L. brevifrons* giving the orbits a deeper appearance in dorsal view than in *L. tridentatus.* Sakai (1965) figures a specimen of *L. brevifrons* in which the external orbital spines project forwards very much further than in specimens previously recorded.

6. "Abdomen (male) as in *L. tridentatus,* but the median tubercle on the third tergum is rudimentary. The long spine on the fourth tergum is projecting backward and then upward at the tip." These characters provide no distinction between the two species because of the wide variation in *L. tridentatus.*

7. There are no differences between *L. brevifrons* and *L. tridentatus* in the characters of the cheliped except for slightly longer spines on the carpus in the former. Sakai's (1937) figure (42a) of the chela of *L. brevifrons* suggests a major difference, in relation to the number of spines on the ventral edge which, however, is swamped by the wide variation in *L. tridentatus;* it can be seen from Sakai's (1937) figure of this species (pl. XVI fig. 6) that only the left chela possesses four ventral spines.

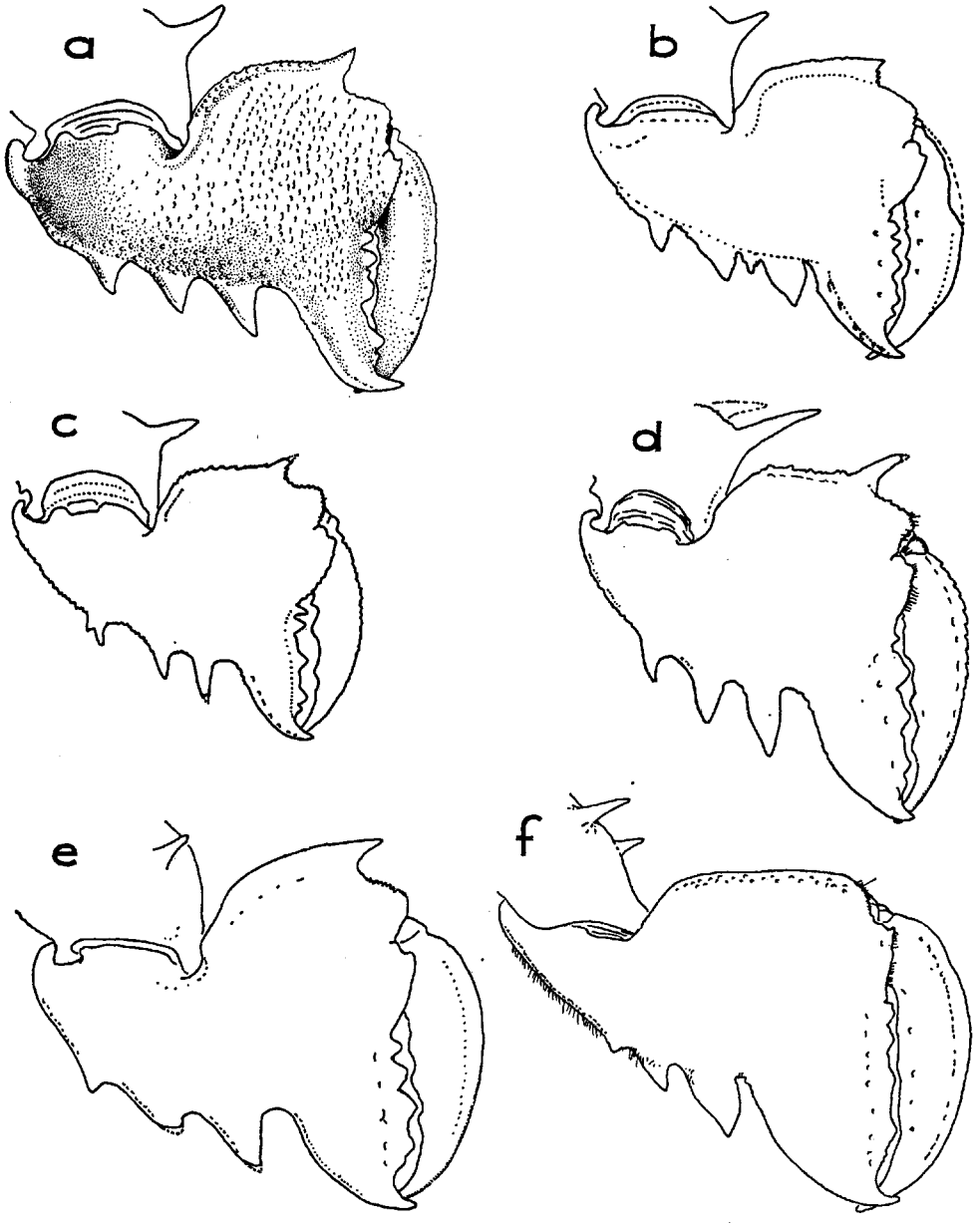

FIG. 7.—Outer face of right chela of *Lyreidus* species. a, *L. tridentatus,* ♂, 39.9mm, Japan (AM P.10499); b, *L. tridentatus,* ♀, 41.7mm, Japan (AM P.10500); c, *L. brevifrons,* ♂, 32.2mm, off Honshu, Japan (USNM 57687); d, *L. brevifrons,* ♂, 30.5mm, South of Hainan (AM P.15782); e, *L. stenops,* ♀ 41.6mm, south of Hong Kong (AM P.15778); f, *L. channeri,* ♂, 30.0mm, south of Hainan (AM P.15787).

8. "The sternum is more strongly constricted between the bases of the chelipeds than in *L. tridentatus*." This is rather difficult to discern: whereas the shape of the lateral wings of the first sternite—truncate or rounded in *L. tridentatus*, acute in *L. brevifrons*—is obvious in Japanese specimens; in specimens of *L. brevifrons* from the South China Sea the lateral wings of the sternum are rounded.

9. "The form of the apex of the male first pleopod is quite different in the two species." The present study confirms this.

Thus the most reliable features differentiating these two very similar species are the width between the tips of the external orbital spines relative to the greatest carapace width, the shape of the external orbital spines, rostrum and anterolateral borders and the form of the apex of the first pleopod in the male. In addition, the anterolateral border of the carapace, the dorsal border of the palm of the chela and dactyl of the cheliped are more distinctly granular in *L. brevifrons*. This is particularly well borne out by a specimen of *Lyreidus* from Japan in the Australian Museum's collections (AM P.10500) which has strongly curved lateral spines and four distinct teeth on the ventral edge of one of the chelae but is clearly *L. tridentatus* because of the shape of the carapace, and the shortness and broadness of the external orbital spines and rostrum.

Examination of photographs and drawings of the specimen recorded from off Dar-es-Salaam by Doflein (1904) (kindly sent by Dr H. E. Grüner) shows that this specimen is actually *L. brevifrons*. It possesses a narrow front, strongly concave anterolateral borders of the carapace, the outer margins of the slender external orbital spines being subparallel, slender rostrum, strongly curved lateral spines, greatest carapace width well behind these and exceeding the width between the tips of the lateral spines, and the sternum is laterally subacute anteriorly.

GEOGRAPHIC DISTRIBUTION: Western Indian Ocean: Dar-es-Salaam. Western Pacific Ocean: South eastern Japan, South China Sea near Hong Kong and west of the Philippines.

BATHYMETRIC DISTRIBUTION: Continental slope from 103 to 216 fms.

Lyreidus stenops Wood-Mason, 1887, Figs. 1; 6c, h, g; 7e; 8d. Pl. 2A.

Lyreidus stenops Wood-Mason, 1887: 209, pl. 1 figs. 7, 8 (type locality: Hong Kong; holotype (female) in collections of Zoological Survey of India, Calcutta—reg. no. 8467/6).

Lyreidus integra Terazaki, 1902: 217, text-fig. (type locality: Japan; location of types unknown—probably not extant—T. Sakai, pers. comm.). Sakai, 1965: 5, pl. 2 fig. 2.

Lyreidus integer (sic); Utinomi, 1958: 73, pl. 37 fig. 3.

Lyreidus politus Parisi, 1914: 311, pl. 13 fig. 5 (type locality: Enoshima, Sagami Bay, Japan; holotype (male) in Museo Civico di Storia Naturale, Milan—reg. no. 1286). Gordon, 1931: 532. Yokoya, 1933: 112. Sakai, 1934: 283, pl. 18 fig. 5; 1936: 68, pl. 13 fig. 4; 1937: 172, text-fig. 43.

LOCALITIES PREVIOUSLY REPORTED: Japan: "Japan" (Terazaki). Manazuru, Sagami Bay (Sakai, 1934, 1937). Enoshima, Sagami Bay (Parisi). Off Enoshima and west of Jogashima, Sagami Bay, 85 m. (Sakai, 1965). Simoda, Kii Peninsula; Seto (Sakai, 1934, 1937). Tosa Bay (Sakai, 1937). Kagoshima (Yokoya).

South China Sea: Hong Kong (Wood-Mason, Gordon).

MATERIAL EXAMINED: A total of seven specimens, as follows:—Locality unknown: "Chile", 1 ♂, 34.0mm (det. "*Lyreidus inermis* A. Milne Edwards"—MP unreg.).

Japan: Japanese Seas, before April 1934, pres. T. Sakai, 1 ♂, 30.8mm (AM P.10501).

South China Sea: Hong Kong, 30–40 fms, mud, before 1930, Barney, 1 ♂, 37.0mm (BM 1930.12.263–66). S. of Hong Kong, 21°20′N., 114°25.6′E., 46 fms, Agassiz trawl, 24/4/1965, FHK Sta. 15, 1 ♀, 41.6mm (AM P.15778). S. of Hong Kong, 21°11.3′ to 21°10.7′N., 114°26′E., 44–45 fms, mud and coarse sand, Agassiz trawl, 24/7/1965, FHK Sta. 9, 1 ♂, 31.4mm (AM P.15779). S. of Hong Kong, 21°17.5′N., 11°28.5′E., to 21°20′N., 114°25.6′E., 46 fms, mud, Granton trawl, 24/4/1965, FHK Sta. 13, 1 ♀, 37.4mm (AM P.15780).

Philippines: S. of Panglao Is, off Bohol, 40–77 fms, sand, "Pele", Mary E. King, 8/2/1964, 1 ♀, 11.0mm (WAM 350–67).

REMARKS: This species has been best known as *L. politus*. Recently Sakai has pointed out that Terazaki (1902) had earlier described this species as *L. integra;* Terazaki's paper had been overlooked by later carcinologists. However, the species was first described by Wood-Mason as *Lyreidus stenops*. Wood-Mason's remarks on this species come at the end of the explanation of pl. 1 in his 1887 paper. "This species may at once be distinguished from its congeners by its narrow metope, its unarmed carapace and its decumbent abdominal spine. A single specimen of it, with a male and two females of another species identical with the specimen from Japan referred in the above description [of *L. channeri*] to *L. 3-dentatus* [sic], has been received by me from Hong Kong from Brigade-Surgeon Hungerford, since this paper was written". Wood-Mason's figures show the abdomen in dorsal and (of segments 3–5) in lateral view (Fig. 7) and the carapace (Fig. 8) of this female specimen. This species, according to Wood-Mason's figures, agrees with descriptions and figures of *L. politus* given by Parisi (1914) and by Sakai (1934, 1937) in all features of the carapace and abdomen, except that the distance between the external orbital spines is slightly greater in Wood-Mason's figure of *L. stenops* than in published figures of *L. politus*. In my opinion, therefore, *Lyreidus stenops* is the oldest available name for the species up to now variously known as *Lyreidus politus* and *Lyreidus integra.*

There is a dry specimen of a species of *Lyreidus* in the collections of the Muséum National d'Histoire Naturelle, Paris, labelled "*Lyreidus inermis* A. Edw. Chili." This specimen is referrable to *L. stenops*. It possesses a narrow front, unarmed carapace and the carpus of the cheliped possesses a single spine. No species of *Lyreidus* has ever been reported from the east Pacific and all other eastern Pacific raninids (see Rathbun, 1937) are quite different from species of *Lyreidus*. The locality given on the label of this Paris Museum specimen therefore, can only be regarded at the present time as erroneous.

GEOGRAPHIC DISTRIBUTION: Western Pacific Ocean: South-eastern Japan; South China Sea near Hong Kong, Philippines.

BATHYMETRIC DISTRIBUTION: Continental shelf from 30 to 77 fms.

Lyreidus channeri Wood-Mason, 1885, Figs. 6d, i, r; 7f; 8e. Pl. 2B.

Lyreidus channeri Wood-Mason, 1885: 104 (type locality: Bay of Bengal, 21°6′30″N., 89°20′E., 405–285 fms, dredged in trawl; holotype (male) in collections of Zoological Survey of India, Calcutta—reg. no. 8468/6); 1887: 206–208, pl. i figs. 1–6. Alcock, 1896: 294–5. Kemp and Sewell, 1912: 29.

Lyreidus gracilis Wood-Mason, 1888: 376 (type locality: off Port Blair, Andaman Sea, 271 fms; holotype (female) in collections of Zoological Survey of India, Calcutta—reg. no. 8567/6).

LOCALITIES PREVIOUSLY REPORTED: Bay of Bengal, 200–405 fms; Andaman Sea, 220–271fms (Wood-Mason 1885, 1887, 1888; Alcock). Arabian Sea, off Trivandrum, 237 fms, "Investigator" Sta. 391 (Kemp and Sewell, 1912).

MATERIAL EXAMINED: One specimen, as follows:—South China Sea: S. of Hainan, 16°47.5′N., 109°49.5′E., to 16°45′N., 109°52′E., 200–290 fms, fine mud, Agassiz trawl, 5/3/1965, FHK Sta. 17, 1 ♂, 30.0mm (AM P.15787).

REMARKS: The single specimen agrees fairly well with Wood-Mason's description (Wood-Mason, 1887) but the anterior of the two lateral spines is represented by a small, blunt lobe on the right side and an obscure bump on the left side. The external orbital spines are parallel and level with the acuminate rostrum. The eyestalks are compressed and the pigment is equally well developed in both eyes although the cornea is difficult to see in dorsal view. The distal tooth on the ventral edge of the chela is about three times the size of the proximal and there is a very small blunt tooth near the base making three teeth in all. The inner edge of each dactyl is obscurely tridentate, not bidentate. The merus of each cheliped has a

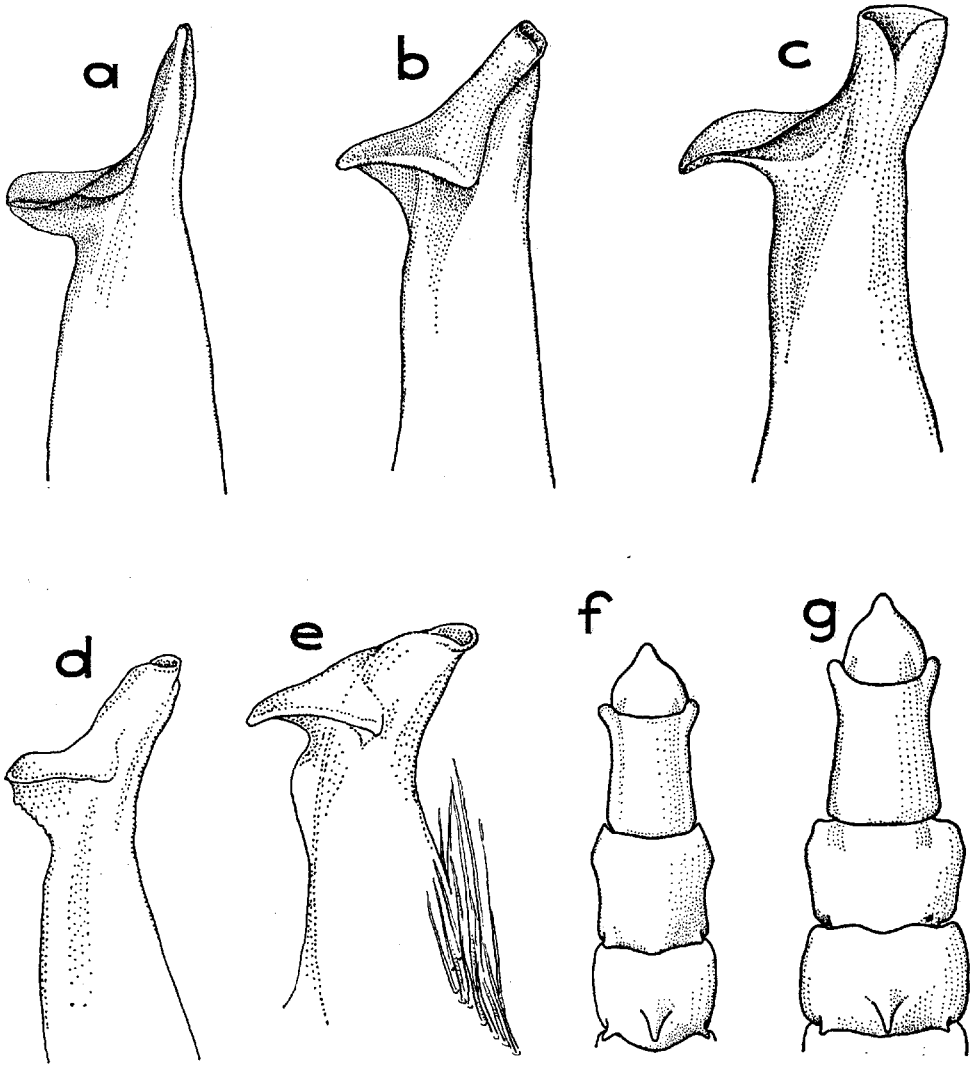

FIG. 8.—Male left first pleopods, tip, medio-abdominal aspect, of *Lyreidus* species (a-e) and abdomen, segments 4–7, of *L. tridentatus* (f, g). a, *L. tridentatus,* 28.3mm, Misaki, Japan (USNM 63689); b, *L. tridentatus,* 39.9mm, Japan (AM P.10499); c, *L. brevifrons,* 32.2mm, off Honshu, Japan (USNM 57687); d, *L. stenops,* 31.4mm, south of Hong Kong (AM P.15779); e, *L. channeri,* 30.0mm, south of Hainan (AM P.15787); f, *L. tridentatus,* ♂, 43.0mm, off Castlepoint, New Zealand (DM Z.Cr.615); g, *L. tridentatus,* ♀, 38.2mm, off Castlepoint, New Zealand (DM Cr.1058).

enough to warrant specific separation for this single specimen. The lack of a strong anterolateral spine in front of the long slender one not far from the widest part of the carapace in this specimen may be due to breakage during life whilst the difference in the shape of the rostrum (Wood-Mason describes and figures it as apically rounded) is due to breakage during life in Wood-Mason's specimen as noted by Alcock (1896: 295). The carapace features described by Wood-Mason—ridges and depressions—are obscure but the coarser granulations of the surface anteriorly are obvious.

low, blunt, dorsal spine proximally. Finally, the central spines on the third and fourth abdominal segments are short and blunt. These differences are not important

GEOGRAPHIC DISTRIBUTION: Northern Indian Ocean: Bay of Bengal and Andaman Sea near Ceylon. Western Pacific Ocean: South China Sea west of the Philippines.

BATHYMETRIC DISTRIBUTION: Continental slope from 200 to 405 fms.

DISCUSSION

Examination of the specimens on which this report is based has shown clearly that there is wide variation in all four Recent Indo-west Pacific species of *Lyreidus*. This variation concerns almost all features—carapace shape, prominence of spines and granules, shape of chelae and ambulatory dactyls and shape of sternum. These changes are correlated with growth or are differences due to sex. Such variation makes discrimination between species very difficult.

Within any group of similar species differences of three kinds may exist. The species may differ from each other: 1, in the range of variation, in which case statistical tests would show the mean values to be significantly different although the variances would be approximately the same; 2, in the extent to which they varied, i.e., the mean values would be similar but the variances would differ significantly; or 3, there may be differences in gross structure such as number of spines, tubercles, ridges, etc. It is this third kind of difference which immediately separates the four Indo-Pacific species of *Lyreidus* into three groups—*channeri, stenops* and *tridentatus-brevifrons*. *L. tridentatus* and *L. brevifrons* are distinguished by differences of the first kind—both show changes of the same kind with growth and possess generally the same number of spines and tubercles although there are a very small number of differences in relative proportions of some spines. Within this framework, if variation in any adequate population sample is wide, or narrow but correlated with growth, then only rigorous analysis can provide data which would allow distinctions both valid taxonomically and likely to represent any reasonable approach to reality. Historically, descriptions of new species of animals have been in general based on differences of the third kind—structural differences; these are the much more obvious ones. Presumably, it is for this reason that both Ward's and Bennett's species have been regarded with suspicion: their "species" were based on differences of the first kind but were supported by inadequate data.

It is also evident from the present study that within *Lyreidus* only two species could be distinguished which possess a single spine at about the middle of the lateral margin of the carapace, and the other features common to *L. tridentatus* and *L. brevifrons*. Thus it seems doubtful that Glaessner's *L. elegans,* from the New Zealand Miocene, is a species distinct from *L. tridentatus;* the stated differences between the two include the position of the lateral spines, relative width of the front and shape of the anterolateral margins. However, it appears clear that in certain features New Zealand populations of *Lyreidus* differ slightly but in a constant manner from Australian ones and are therefore probably in the course of becoming a species distinct from those to which the Australian populations belong. The small number of Japanese specimens examined suggests that variation is slightly greater in Japanese populations than in Australian and New Zealand ones.

The present zoogeography of the genus—three species distributed throughout the northern Indo-west Pacific and one in the western Pacific and south-eastern Indian Ocean provides no precise evidence as to areas of evolution of the genus. It is obvious only that the genus was at one time much more widely distributed than at present. Fossil species are known from the Oligocene of Europe but the precise relations of these to Recent species is quite unclear as in most cases the fossil remains are only fragmentary.

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