On the taxonomy of the genus *Nannocalanus* Sars, 1925 (Crustacea, Copepoda: Calanidae)

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Nannocalanus elegans sp. n. from the Southeastern Pacific is described and illustrated. Females of this species differ from those of *N. minor* (Claus) in the shape of the body, outline of the genital segment (in lateral view), and relative size of valve flap. The inner edge of B1 P5 of males and females is with 9-17 denticles (average 12-13), while with 13-26 denticles (average 18-20) in *N. minor* from the same locality. The inner edge of left B1 P5 is entirely serrated in males of *N. elegans*, but without denticles in the distal 15-20% of its length in *N. minor*. Sewell's (1929) *N. minor* f. *major* and *N. minor* f. *minor* from the Indian Ocean are probably distinct species.

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Introduction

The genus *Nannocalanus* Sars, 1925 with the only species *N. minor* (Claus, 1863) is considered to be widely distributed in tropical and subtropical waters of the World ocean. It was found also in the cold waters of the Antarctic Region. Tanaka (1964, cit. after Bradford, 1971) recorded *N. minor* from 55°22'S. Bradford (1971) has found one damaged specimen of this species in the Ross Sea at station 466 (78°26'S, 174°50'W) in the haul 550-0 m. The distribution of *N. minor* in the Southern Hemisphere is shown by Brodsky (1967, Fig. 9).

In the Southeastern Pacific north of 42°S, copepods of this genus were present practically in all samples from the upper 200-meter layer. It was observed that specimens with characters agreeing with those given in the literature for females of *N. minor* were of two types. One form, more abundant, with relatively widely rounded head, was identified as *N. minor*. The other form had a narrower body and pointed head. More detailed examination of the latter specimens has shown that they belong to a separate species described below as *N. elegans* sp. n.

The following abbreviations are used in the descriptions: *C*, cephalon; *Cth*, cephalothorax; *Th1-Th5*, 1st-5th thoracic somites; *Abd1-5*, 1st-5th abdominal somites; *A1*, antennule; *A2*, antenna; *Md*, mandible; *P1-P5*, swimming legs of first-fifth pairs; *Re*, exopodite; *Ri*, endopodite; *Re1-Re3*, first-third segments of exopodite; *Ri1-Ri3*, first-third segments of endopodite; *B1*, coxopodite; *B2*, basipodite. All scale lines equal 0.1 mm.

Material and methods

The samples of zooplankton with *Nannocalanus* were collected in the expeditions of the Atlantic Research Institute of Fishery and Oceanography (AtlantNIRO) in the Southeastern Pacific by R/V-8087 "Otkrytie" in November 1987 and R/V 8080 "Ekliptika" in December 1988 – January 1989, off the 200-mile economic zone. Collecting was performed with a Juday's net with 0.1 sq. m mouth and 0.168 mm mesh size in vertical hauls from 100 or 200 m depth to the surface. Specimens were preserved in 4% formaldehyde/seawater soon after capture and examined with optical microscope P-14. For comparison of *N. elegans* sp. n. and *N. minor*, only specimens from samples containing both species were examined.

Nannocalanus minor (Claus, 1863)
(Figs 6-9, 19-26, 44)

For detailed bibliography and geographical distribution see Vervoort (1949, 1963). Several recent references are given below.

Material examined: 20 ♀ and 30 ♂.

Table. Characters of *Nannocalanus minor* (Claus) and *N. elegans* sp. n. from the SE Pacific

Species	Sex	No.	Size (mm)		P5	Number of denticles on B1 P5	
			range	mean		range	mean
N. minor	female	20	1.56-2.00	1.75		14-25	18.21
	male	30	1.50-1.76	1.64	left	16-26	19.67
					right	13-23	17.23
N. elegans	female	20	1.56-2.08	1.75		10-17	12.88
	male	13	1.50-1.80	1.64	left	10-14	12.46
					right	9-14	11.69

Appearance, mouthparts and P1-P5 of females and males as in descriptions and illustrations of *N. minor* from other regions of the World ocean (Giesbrecht, 1892; Sewell, 1929, 1947; Mori, 1937; Dakin & Colefax, 1940; Brodsky, 1962, 1972; etc.). Inner edge of B1 P5 with 13-26 denticles (Table; Fig. 1). Inner edge of the left B1 P5 of male without denticles distally in about 15-20% of its length.

Sewell (1929) noted two forms of *N. minor* from the Indian Ocean: *N. minor* f. *major* and *N. minor* f. *minor*. They differ in the body sizes, relative sizes of genital field of females, and relative lengths of external spines on Rel P2 and Re2 P2 and terminal spine of Re3 P5.

Females of *N. minor* from Southeastern Pacific cannot be attributed to one of these forms: external spine on Rel P2 is relatively shorter than in females of both forms; external spine on Re2 P2 is relatively longer than in *N. minor* f. *minor*, but shorter than in *N. minor* f. *major*. Relative length of the terminal spine on Re3 P5 corresponds to that in *N. minor* f. *major*, but the relative size of the genital field corresponds better to that of *N. minor* f. *minor*.

Nannocalanus elegans sp. n.
(Figs 2-5, 10-18, 27-43)

Material examined. 29 ♀ (1.95-2.22 mm, average = 2.078 mm) and 8 ♂ (1.85-1.95 mm, average = 1.90 mm) from the cruise of R/V-8087 and 56 ♀ (1.70-1.94 mm, average = 1.81 mm) and 5 ♂ (1.58-1.66 mm, average = 1.63 mm) from the cruise of R/V-8080.

Holotype. Adult ♀, total length 2.0 mm, Southeastern Pacific, 30°00'S, 77°00'W, t° surf. = 16.4 °C, S‰ = 34.58‰, t° 100 m = 15.8 °C, S‰ 100 m = 34.58‰, R/V-8087, 11.XI.1987, vertical haul 100-0 m, Juday net. Dissected and mounted on one slide in glycerin-gelatin. Reg. no. 90720 (Zoological Institute, St.Petersburg).

Paratypes. 8 ♀, total length 1.84-2.06 mm, Southeastern Pacific, 29°S, 77°W, t° surf. = 17.1 °C, S‰ = 34.62‰, R/V-8087, 12.XI.1987, vertical haul 100-0 m, Juday net, in 4% formaldehyde/seawater, Reg. no. 90721 (Zoological Institute, St.Petersburg); 1 ♂, total length 1.95 mm, 31°S, 76°W, t° surf. = 16.6 °C, R/V-8087, 10.XI.1987, vertical haul 100-0 m, 10.XI.1987, Reg. no. 90722 (Zoological Institute, St.Petersburg); 10 ♀, total length 1.8-2.0 mm, 36°40'S, 89°30'W, vertical haul 200-0 m, t° surf. = 19.9 °C, in formaldehyde (Zoological Museum of the Moscow State University).

Description. Female. Total length, excluding caudal setae, 1.7-2.2 mm (n = 85). Body shape similar to that of *N. minor*, but Cth slenderer in

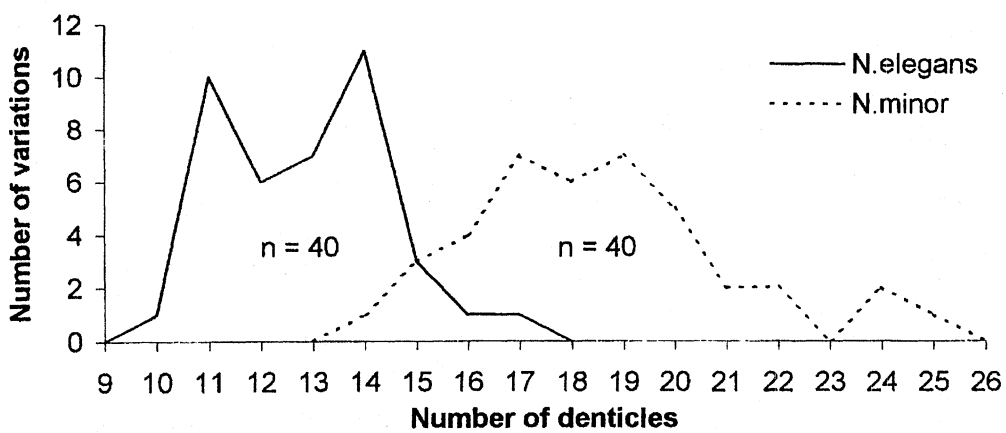
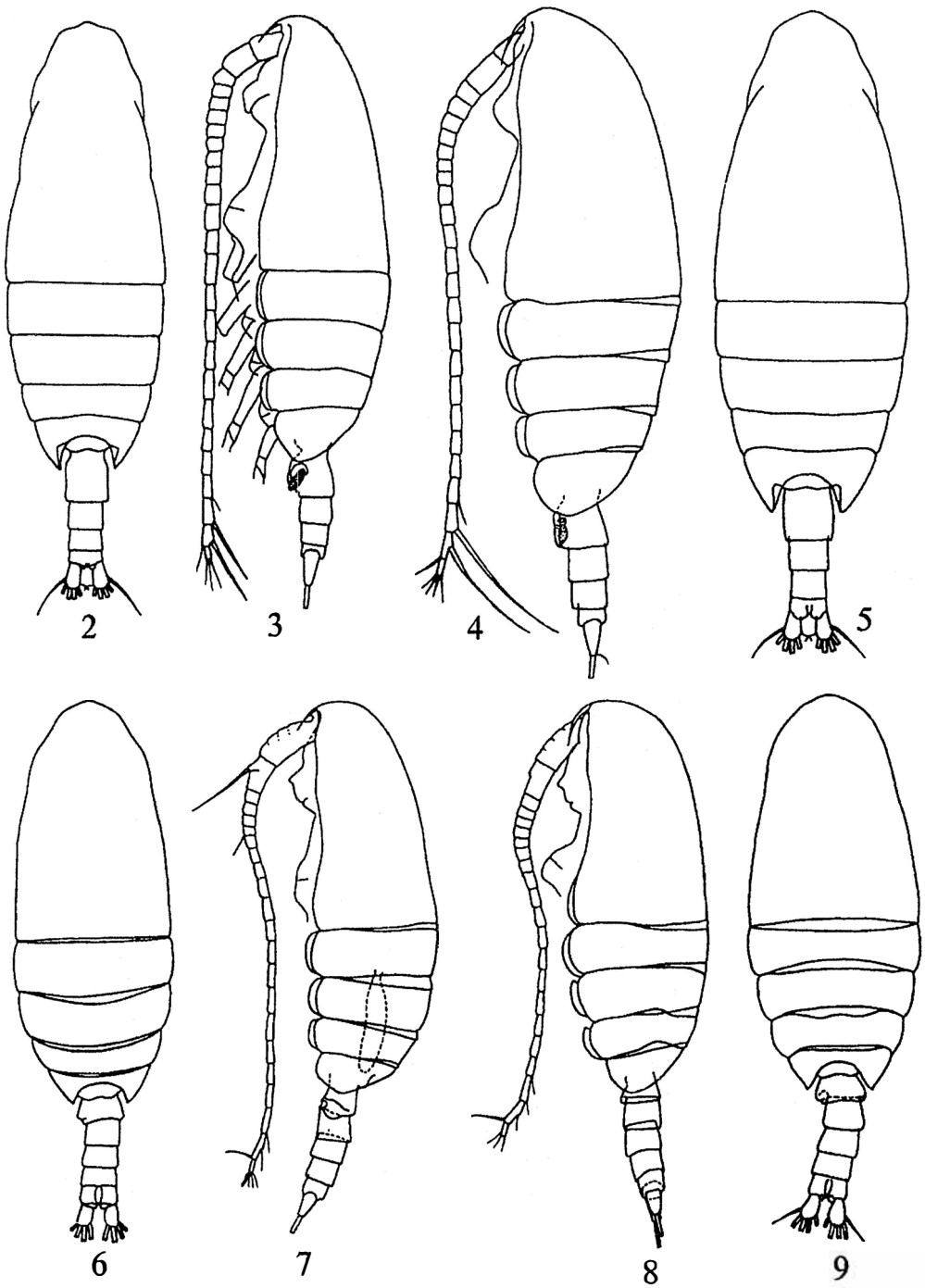
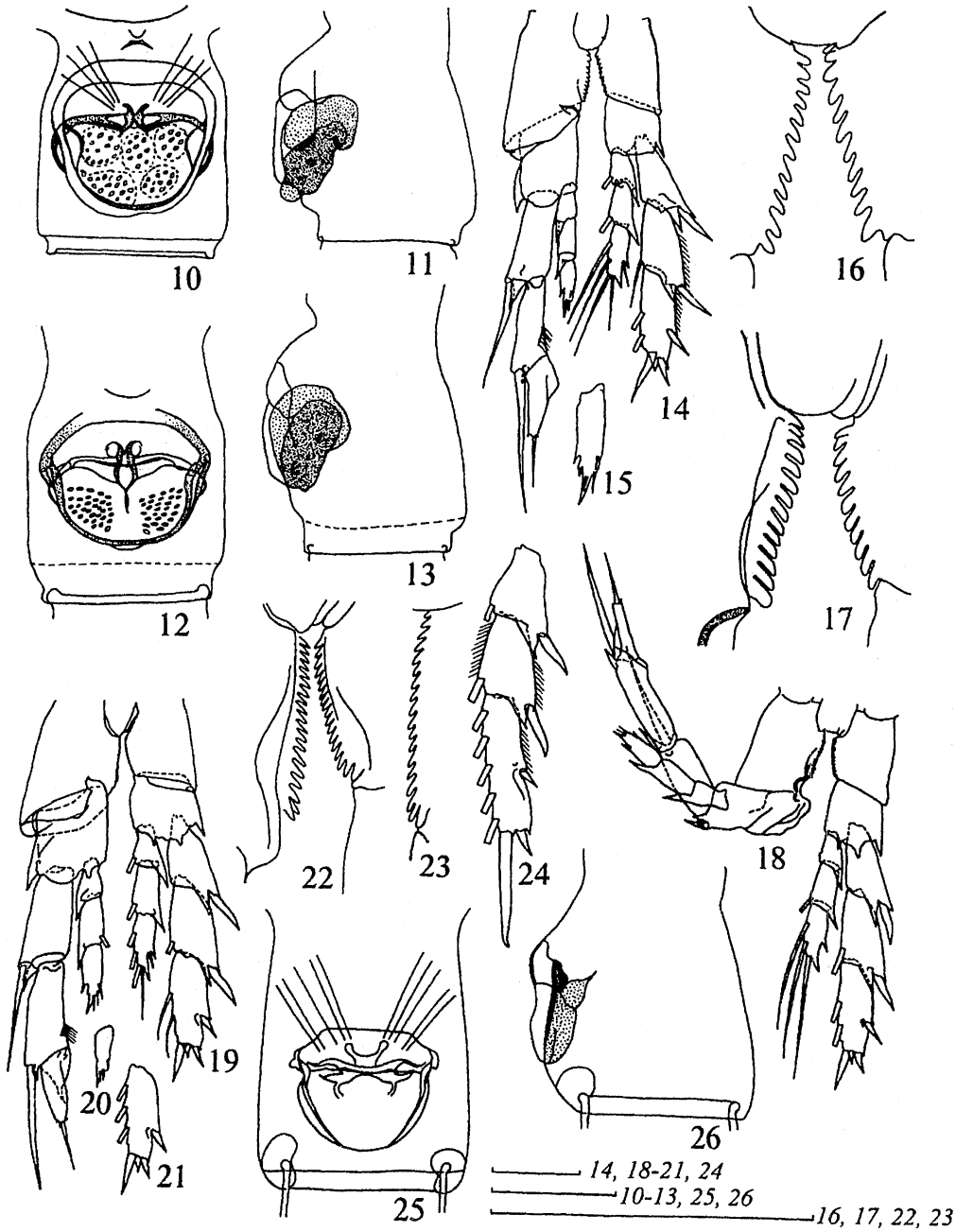


Fig. 1. Frequency distribution of number of teeth on the inner edge of B1 P5 (both left and right B1) in females of *Nannocalanus elegans* sp. n. and *N. minor* (Claus).



Figs 2-9. Habitus of *Nannocalanus elegans* sp. n. (**2-5**) and *N. minor* (Claus) (**6-9**). **2**, **3**, female, holotype; **4**, **5**, male, paratype; **6**, **7**, female; **8**, **9**, male. 2, 4, 7, 9, dorsal view; 3, 5, 6, 8, left side view.



Figs 10-26. *Nannocalanus elegans* sp. n. (10-11, 16, holotype; 12-15, 17, 18, paratypes) and *N. minor* (Claus) from the SE Pacific (19-22, male, 23-26, female). **10-13**, Abd1 ventral and left side; **14**, P5 of male; **15**, Ri3 P5 of an another male; **16**, inner edge of B1 P5 of female; **17**, the same of male (from Fig. 18); **18**, P5 of the male with left P5 turned outside; **19**, P5, dorsal; **20**, **21**, left and right Ri3 P5 of another male; **22**, inner edge of B1 P5 of male; **23**, inner edge of B1 P5 of female; **24**, Re P2; **25**, **26**, Abd1, ventral and left side view.

lateral view, with more flattened cephalon sharply narrowed to the head apex. Length/width ratio of Cth about 3.5 : 1, as opposed to 2.9 : 1 in *N. minor*. C and Th1 fused; Th4 and Th5 separated. Posterior corner of Th5 rounded in lateral view. Ratio of Cth to Abd length 3.2 : 1, like in *N. minor*. Abd of four somites. Abd1 (genital double somite) protruding ventrally in lateral view. In dorsal view, it is the largest somite equal in length to 2nd and 3rd somites combined. In lateral view, spermathecae and anterior edge of somite form an angle of about 30-40° (in *N. minor*, 10° or less). Genital field occupies 85-88% of somite width in ventral view (in *N. minor*, about 75%). Caudal rami 1.5 times as long as wide, each with 5 distal setae and a fine ventral seta. Rostrum with two filaments.

Antennule 24-segmented, reaching the apex of Abd4. Articulation between segments 8 and 9 modified by partial fusion. A peculiar triangular seta on anterior distal edge of segment 8 (type 2 of Fleminger, 1985, p. 277; see also Bowman, 1978) is well visible and surrounded with space not colourable by methylene bleu (Fig. 28). Segments 23 and 24 each with a very long plumose seta on posterior surface.

Antenna: B1 with 1 inner seta; B2 with 2 unequal setae at inner distal corner. Ri slightly longer than Re, 7-segmented, with segments 1 and 2 each bearing 2 setae and segments 3 to 6 each bearing 1 seta.

Mandible: gnathobase of typical appearance, elongate, with cutting edge of 1 large ventral, 4 central, 3 small dorsal teeth and 1 plumose seta dorsally. Ri1 with prominent lobe.

Maxillule: gnathobase with 14 setae and 2 small spines. Second and third inner lobes with 4 setae. First outer lobe with 7 large and 2 small setae. Basis fused with Ri and bearing 4 setae; Ri presumably with 4, 4, and 7 setae. Re with 11 setae.

Maxilla: lobes 1 to 5 with 6, 3, 3, 3 and 4 setae; distal part of Ri with 8 + 1 small setae. Lobe 2 with a plumose seta on the outer margin.

Maxilliped: Ri 1 to 6 with 3, 2 + 4, 4, 3, 3 + 1 and 4 setae.

P1-P5 with 3-segmented Re and Ri. B1 P1 with a long inner seta; distal part of B2 P1 with a curved, long inner seta. External spine of Re2 P2 relatively small, not reaching the base of middle spine of Re3 P2. Inner edge of B1 P5 with 10-17 small teeth (Table; Fig. 1). Ri3 P5 with 3 inner long, 1 outer and 1 terminal small seta. Length of terminal spine of P5 1.15 times that of Re3.

Male. Total length 1.5-1.8 mm (n = 13). Body a little shorter and broader than in female. Head more rounded in lateral view. Ratio of Cth to Abd length 3 : 1. Abd 5-segmented with the first segment extended on the left side. Caudal rami 1.5 times as long as wide. A1 22-segmented, reaching apex of Abd4. Mouthparts well developed. P1-P4 as in female. P5 as in *N. minor*, but segments of Re and Ri slenderer. Inner edge of right B1 P5 with only 9-14 small teeth, that of left B1 P5 entirely serrated.

Etymology. The Latin "elegans" means elegant, smart.

Remarks. N. elegans sp. n. is most readily distinguished from *N. minor* of Southeastern Pacific by the shape of the body in lateral view, genital field structure of female, number of small teeth on the inner edge of B1 P5 in both sexes, and structure of the inner edge of the left B1 P5 of male.

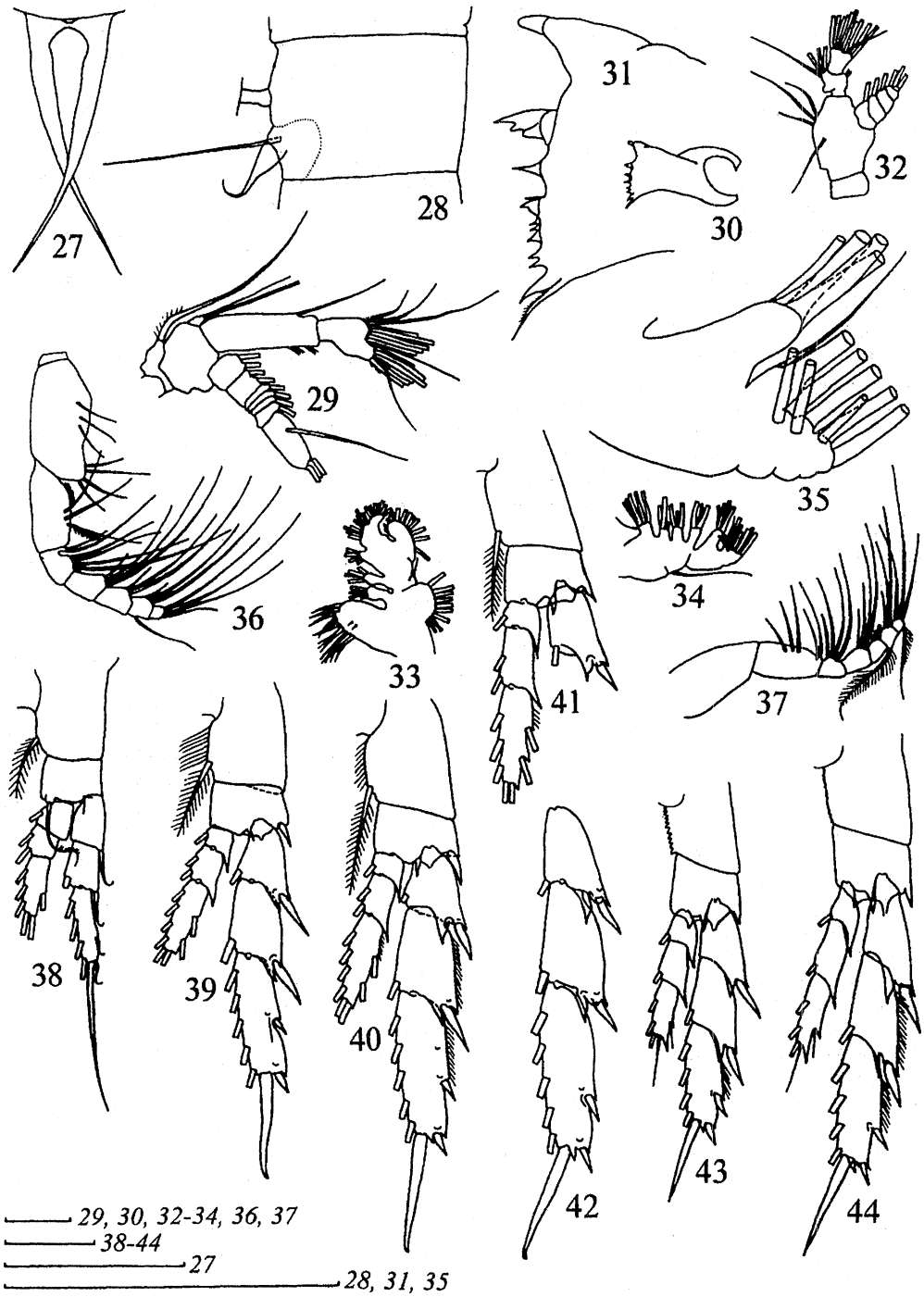
Distribution. In November 1987, the region from 10°S to 30°S was surveyed. *N. elegans* was recorded only at stations near 30°S with surface temperature 16.6-17.2 °C. To the north, temperature of water surface was higher. In January-February 1989, the region from 36°S to 41°S and from economic zone to 90°W was surveyed. *N. elegans* was discovered only in the northern part of this region, north of 38°30′S, with temperature of water surface more than 19.5 °C and salinity more than 34.20‰ (to the south, the salinity was less). In this planktonic survey, *N. elegans* was found almost always in samples together with the tropical species *Undinula darwinii* (Lubbock).

Discussion

The genus *Nannocalanus*, established by Sars (1925) for the single species *Calanus minor* Claus, was treated as a junior synonym or subgenus by some later authors (see Vervoort, 1949; Brodsky, 1965, 1967, 1972; Bradford & Jillett, 1974), but accepted as a separate monotypic genus in recent publications (Bradford, 1988; Bradford-Grieve, 1994).

As *N. minor* s. l. from the Southeastern Pacific is now subdivided into 2 clearly differing species, it becomes evident that other species, very close to *N. minor* s. str., could be detected, if material of *Nannocalanus* from other regions will be revised.

As a matter of fact, Sewell's (1929) *N. minor* f. *major* and *N. minor* f. *minor* are sufficiently differing species, rather than forms. In addition to the distinctions mentioned by Sewell (1929), it is well notable, that genital fields of females



Figs 27-44. *Nannocalanus elegans* sp. n. (**27-36**, **38-41**, **43**, female, holotype; **37**, **42**, paratypes) and *N. minor* (**44**). **27**, rostrum; **28**, 8th segment of A1; **29**, A2; **30**, **31**, mandibular blade; **32**, mandibular palp; **33**, Mx1; **34**, Mx2; **35**, distal end of Mx2; **36**, Mxp; **37**, Mxp of male; **38-41**, P1-P4; **42**, Re P4; **43**, P5; **44**, P5 of 2.2 mm long female.

of these "forms" differ in the size (see his text-figs. 2 and 3), occupying approximately 83% and 69% of the width of the genital segment respectively (see the same character in *N. minor* and *N. elegans* from the Southeastern Pacific). Sewell (1947, p. 14-15, text-fig. 1) illustrated also distinctions in the structure of the male P5 of these "forms"; they concern the relative length of internal serrated part of B1 edge in left and right P5, length of inner setae on right Re3 P5 (relatively shorter in *N. minor* f. *minor* than in *N. minor* f. *major*), and relative width of right Re3 P5.

The heterogeneity of *N. minor* was noted by Dakin & Colefax (1940): "... numerous individuals differed from the typical form in that the head was separated from the 1st thoracic segment instead of being fused with it, and the proportion of the abdominal segments were also atypical".

Vervoort (1949) refers to Candeias's observations that in some specimens of *N. minor* from Portugal area the lateral corners of Th5 seemed longer than in other specimens.

The genetic analysis of *N. minor* s. l. from the northern Atlantic (Bucklin et al., 1996) has shown that this species is represented there by two groups of specimens differing in the size and geographical distribution, they may correspond to the two Sewell's forms or, more likely, to other species.

Hence, *Nannocalanus* is a separate genus including at least 2 species, *N. minor* (Claus) and *N. elegans* sp. n.; examination of specimens from various regions of the World ocean may result in discovery of further species of this genus.

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