SYSTEMATICS AND BIOLOGY OF THE SEPIOLID SQUIDS OF THE GENUS ROSSIA OWEN, 1835 IN CANADIAN WATERS WITH A PRELIMINARY REVIEW OF THE GENUS

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Systematics and biology of the sepiolid squids of the genus Rossia Owen, 1835 in Canadian waters with a preliminary review of the genus

by

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Contents

Abstract

Collections comprising about 325 specimens of *Rossia* from the Canadian Atlantic, Pacific and Arctic are reported upon.

The arctic-boreal *R. palpebrosa*, the type species, is redescribed and *R. glaucopis*, *R. sublevis*, *R. hyatti*, and *R. papillifera* are regarded as synonyms. The species is amphi-Atlantic. The boreal *R. megaptera* is redescribed from topotypic material and shown to be a valid species. As presently known it ranges from the Hudson Canyon to Davis Strait. *R. molleri* is shown to be an arctic endemic, the only such known cephalopod; a relict population was found in Hebron Fiord, Labrador. *R. pacifica* is the only species of the genus found off British Columbia; it is amphi-Pacific. Species excluded from the Canadian Atlantic fauna are *R. caroli*, an eastern Atlantic species, and *R. tenera*, a tropical-boreal species which ranges northwards only to Georges Bank.

The subgenus (genus - some authors) *Allorossia*, since founded upon material (*R. glaucopis*) synonymous with the type species of *Rossia*, is left in the synonymy of *Rossia*. The subgenera *Semirossia* and *Austrorossia* are recognized. A total of 18 species are provisionally recognized for the genus.

The gross morphology is briefly considered from a taxonomic aspect. Except for sucker size in some instances, indices of body proportions are of little taxonomic value. The most stable of the characters investigated are the structure of the club, funnel organ, anal papillae and palps and, particularly, the sexual characters of spermatophore and hectocotylus structure.

Eggs ripen in small clusters and individual females spawn several times over a protracted season; ova counts ranged upwards to about 500. Females mature later and attain a larger size than the males. Feeding is principally on benthic crustacea and small fish. A hemiurid trematode was found in the stomach and caecum of a few specimens.

Introduction

The genus *Rossia* was erected by Owen (1835) to accommodate a new species collected in the Canadian archipelago by the Ross Expedition. Since that time about two dozen nominal species have been added, eighteen of which are provisionally recognized in this paper.

Owen originally placed the genus in the Loliginidae but Tryon (1879) subsequently transferred it to the Sepiolidae.

Squids of this genus are small (mantle length usually less than 5 cm) and have a bursiform configuration, leading to such names as "bottleass squid" and "purse squid" in Newfoundland and "bob-tailed squid" in New England. They are benthic on muddy and sandy bottom on the continental shelf and slope.

Quite often, especially in the case of earlier authors, insufficient series of samples have prevented adequate assessment of the extent of variation within species. From a general ignorance of taxonomically stable characters within the group, the criteria used in making specific diagnoses were often based upon artificial characters of fixation or upon characters subject to considerable individual and ontogenetic variation.

In addition to resultant confusion at the specific level, the higher systematics of the group is also a matter of dispute. At present four subgenera are employed by various authors: *Rossia*, *Allorossia*, *Austrorossia*, *Semirossia*. Some authors have favored the elevation of *Allorossia* and *Semirossia* to generic status.

The present paper is intended to clarify the systematics and distribution of the species occurring in the Canadian area and to re-evaluate taxonomic characters used in specific determinations and definition of subgenera. Short notes on growth, maturity, mating, spawning, food and parasites are also given.

For data on hydrography of the study area, the reader is referred to Hachey (1961) for the Canadian Atlantic, Dunbar (1951) for the Canadian eastern Arctic, and Uda (1963) for the Canadian Pacific.

Materials and Methods

Material

The bulk of the material from the Canadian Atlantic was collected, incidental to groundfish otter trawling, by vessels of the Fisheries Research Board of Canada, Biological Station, St. John's. Sampling is thus biased in favor of areas and depths heavily fished for groundfish species. Few sets were made on the Nova Scotian Shelf. Some of this material is deposited in the National Museum of Canada; the great majority is in the invertebrate collections of the St. John's Biological Station.

Collections from the Canadian Arctic west of Hudson Strait and from Ellesmere Island were mostly otter trawled in the Canadian archipelago by the M.V. *Calanus* and M.V. *Salvelinus*, both operated by the Fisheries Research Board of Canada, Arctic Biological Station, Montreal. Most of this material is now in the collections of the National Museum of Canada. Unfortunately no collections were available from the western part of the Beaufort Sea.

The Pacific material (R. pacifica only) consists mainly of all Rossia in the cephalopod collections of the Fisheries Research Board of Canada, Biological Station, Nanaimo, B.C.; these were taken incidental to various trawling and dredging operations in the British Columbia and SW Alaska area. All material in the collections of the National Museum of Canada was also examined.

Measurements and Indices

Body measurements were made using vernier calipers, except for arm lengths which were measured with a steel rule (0.5 mm divisions); sucker and ova diameters were measured using a grid (0.1 mm divisions) under a low power microscope. Weights (to 0.1 g) were taken with a Mettler balance.

Spermatophores were mounted in Turtox CMC-10 medium.

Except for the new Fin Position Index (FPI) and Fin Insertion Index (FII), all measurements and indices employed here are those now in common use in cephalopod taxonomy; these are as defined below. For a more detailed listing the reader is referred to Voss (1963).

DML, dorsal mantle length in mm measured from the anterior-most point of the mantle to the apex of the mantle.

VMLI, ventral mantle length index: length of mantle measured from anteroventral border of the mantle in the midline to the apex of the mantle, as a percentage of dorsal mantle length.

MWI, mantle width index: greatest width of mantle as a percentage of dorsal mantle length.

HLI, head length index: length of head from anterior margin of the nuchal cartilage to the bifurcation of the dorsal arms as a percentage of dorsal mantle length.

HWI, head width index: greatest width of head across eyes as a percentage of dorsal mantle length.

FWI, fin width index: greatest width across both fins as a percentage of dorsal mantle length.

FWIs, fin width index single: greatest width across single fin from junction with mantle as a percentage of dorsal mantle length.

FLI, fin length index: greatest length of fins as a percentage of dorsal mantle length.

FPI, fin position index: distance from anterior margin of fin insertion to anterior mantle margin, as a percentage of dorsal mantle length.

FII, fin insertion index: length of fin insertion as a percentage of dorsal mantle length.

I, II, III, IV, length of dorsal, dorsolateral, ventrolateral and ventral arms, measured on the right side, as a percentage of dorsal mantle length when used in tables and figures. Arm length is measured from the first basal sucker to the tip of the arm. When used in the text, the numbers refer only to the particular arm.

Arm formula, comparative lengths of arms expressed numerically in decreasing order, e.g. 3.4.2.1.

TLI, tentacle length index: total length of tentacle and club as a percentage of dorsal mantle length.

CLI, club length index: length of club as a percentage of dorsal mantle length. Club length is measured from the first basal sucker to the tip.

SIs, sucker index (sessile): diameter of largest arm sucker as a percentage of dorsal mantle length.

SIt, sucker index (tentacular): diameter of largest tentacular sucker as a percentage of dorsal mantle length.

Abbreviations

Specimen numbers commencing R, RP and RM are the author's own register numbers for the material. Where the specimens are deposited in museums, the museum numbers are given. (When unaccessioned, identification numbers from collection data are given, in brackets.) The following abbreviations are employed:

NMC - National Museum of Canada, Ottawa.

USNM - United States National Museum, Washington.

BM - British Museum (Natural History), London.

D - D. H. Steele, private collection.

Systematic Account

Subfamily Rossiinae Hoyle, 1904

Mantle not fused to head. Funnel valve present. Gladius present but reduced in size. One or both dorsal arms of male hectocotylized. Dorsal web present on tentacular club.

Genus Rossia Owen, 1835

Diagnosis: As for subfamily.

Type: R. palpebrosa Owen, 1835 (by monotypy).

Rossia (*Rossia*) *palpebrosa* Owen, 1835

Figures 1, 2

Rossia palpebrosa Owen, 1835, p. XCII, pl. B, fig. 1, pl. C, figs. 2-4. - Grimpe, 1933, p. 501, fig. 3.

Rossia glaucopis Lovén, 1845, p. 121. - Pfeffer, 1908, p. 37, figs. 30-37. - Grimpe, 1933, p. 500, fig. 2.

Rossia papillifera Jeffreys, 1869, p. 134.

Rossia sublevis Verrill, 1878, p. 208.

Rossia hyatti Verrill, 1878, p. 208.

Material: 85 specimens (Appendix I, Table I).

Description: Mantle short, saccular, longer than wide ($\overline{MWI}$ = 78.0), bluntly rounded posteriorly. Anterior margin sinuous, produced dorsally and slightly excavated ventrally.

Fins large ($\overline{FLI}$ = 59.7), with free anterior lobes not reaching mantle margin.

Head large ($\overline{HWI}$ = 70.0), with large bulbous eyes. Olfactory pits rather prominent.

Funnel conical, projecting nearly to bifurcation of ventral arms. Valve small and semi-oval, located near funnel mouth. Dorsal member of funnel organ a broad V shape with rounded apices and long free anterior papilla. Ventral pads slightly arcuate. Anal palps large and bladed.

Arms long, longest about equal in length to mantle ($\overline{III}$ = 104.5). Order variable but third pair always longest and order 3.4.2.1 most common. Ventral pair with prominent dorsal keel extending from tentacular sheath. Weak aboral keel on third pair. Low scalloped protective membranes present on all arms.

Fig. 1. Dorsal view of Rossia palpebrosa, maturing female, DML 42.1 mm (Specimen R-157).

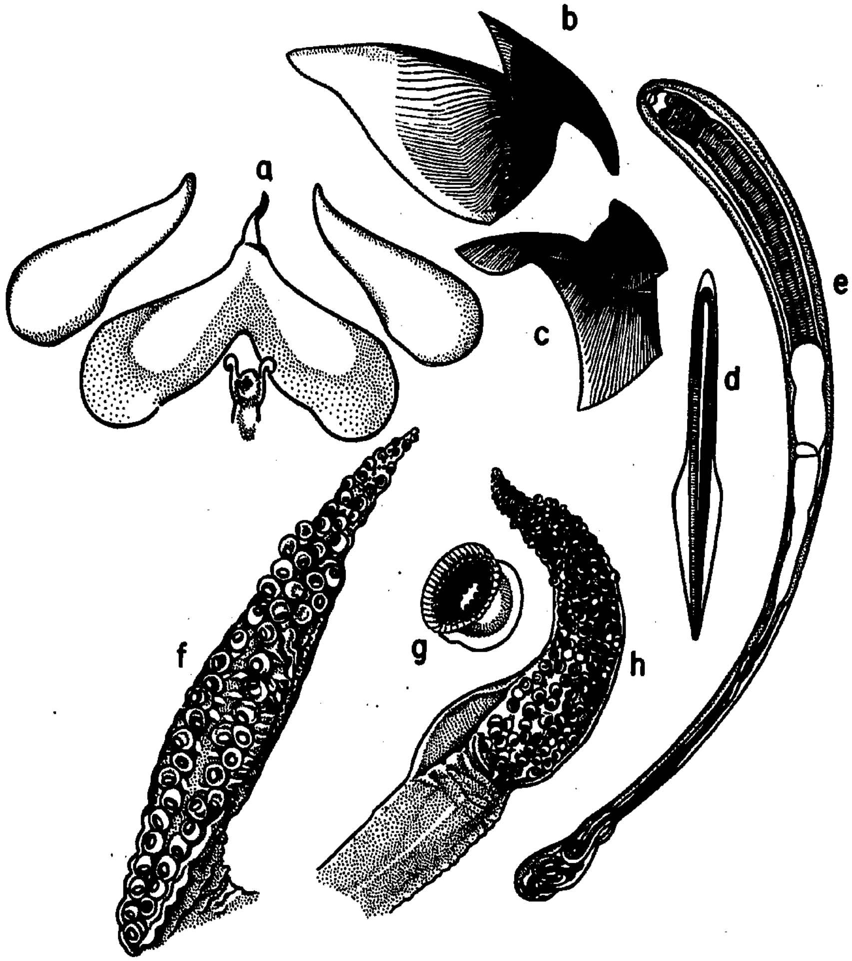

Fig. 2. Rossia palpebrosa: a, funnel organ and anal palps (Specimens R-1, 2); b, upper mandible (Specimen R-96); c, lower mandible (Specimen R-96); d, gladius (Specimen R-133); e, spermatophore (Specimen R-6); f, hectocotylized arm (Specimen R-3); g, club sucker (Specimen R-15); h, club (Specimen R-15).

In males suckers on all but dorsal arms enlarged and generally crowded into 3-4 rows ($\overline{SIs} = 7.4$) whereas in females suckers not enlarged, in two rows only, rarely showing crowded condition ($\overline{SIs} = 6.4$). Margins round and smooth.

Dorsal arms of males <u>hectocotylized</u> in typical <u>Rossia</u> (subgenus) fashion; suckers in two rows except at tips where often crowded into 3-4 rows; smaller than on other arms. Ventral membranes expanded for entire arm length.

<u>Tentacle</u> stalks flattened orally and rounded aborally. Dorsal web present, originating proximal to club, forming prominent semi-oval in carpal region; narrows abruptly and continues as low web to distal tip. Ventral protective membrane extends full length of club. Club suckers in 6-7 rows, largest dorsally and proximally, with blunt teeth on entire margin.

<u>Interbrachial membranes</u> low, missing between ventral pair. Tentacular sheath moderately developed.

<u>Buccal membrane</u> low. Supports of both dorsal and ventral arms united at bases. Arms I, II with dorsal supports; III, IV with ventral supports.

<u>Texture</u> variable, some specimens showing varying amounts of dermal papillation on dorsal surface of head and mantle, others completely smooth.

<u>Color</u> brownish-purple with chromatophores considerably smaller and more densely distributed dorsally.

<u>Type</u>: Not located. No record of it could be found in either the Hunterian Museum of the Royal College of Surgeons of England (Jessie Dobson,

Curator, in litt.) or in the British Museum (Natural History) (Norman Tebble, Curator of Molluscs, in litt.).

Type locality: Elwin Bay, Prince Regent's Inlet (Canadian Eastern Arctic).

Discussion: Joubin (1920) evidently recognized R. palpebrosa, R. sublevis, and R. glaucopis as distinct species. He compared his R. caroli with R. glaucopis but stated that it differed so much from R. sublevis that comparison was useless. Of R. palpebrosa he states (p. 39): "Il est possible de penser que cette espèce est la forme arctique de la R. macrosoma qui est plus méridionale". However the sympatric occurrence of the two species throughout much of their range in the eastern Atlantic precludes any question of subspeciation here. (In deference to Joubin, his suggestion, since published prior to 1961, cannot be construed as an express statement of subspecific or infra-subspecific rank (Int. Code Zool. Nomen. XV Int. Congress Zool. Art. 45 (e)(i)).

Pfeffer (1908) regarded R. palpebrosa as a synonym of R. glaucopis. (He inexplicably retained the latter name although the former, the type species, had priority by ten years!) He dismissed the "Pseudo-Vierreihigkeit" sometimes found as due to contraction of the arms in fixative.

Grimpe (1933), however, maintained the existence of two species, regarding the presence of four rows of suckers on the basal part of the lateral arms as characteristic of R. palpebrosa. In this regard he stated: "Das es sich hierbei nicht um ein zufällig durch die Fixierung enstandenes Artefakt handeln kann".

The synonymy I present (p. 6) is essentially that of Pfeffer (1908) except that the priority of the nomen R. palpebrosa is recognized. The creation of these synonyms resulted from the variability of the species and also from artifacts of fixation.

Distribution: This species is reported from 32° 33'N in the western Atlantic northwards to Baffin Bay and the eastern part of the Canadian archipelago. It occurs in Greenland, Iceland and Spitzbergen and is taken in the Barents and Kara Seas. In the eastern Atlantic it ranges southwards to the west of Ireland, ca. 51°N. For citations of literature pertinent to the distribution see Grimpe (1933).

The record of Jatta (1896) from Naples likely refers to a misidentified R. macrosoma.

R. palpebrosa is an arctic-boreal, sublittoral species. Bottom temperatures for sets in which it was taken by our vessels range from -1.36 to 4.89°C (Fig. 3); depths range from 57 to 300 fathoms (104-549 m) with most specimens taken in 100-150 fathoms (183-274 m, mean 256 m) (Figs. 4 and 5).

Hoyle (1886) has reported the species (= R. sublevis) from off Cape Virgins, South America. However, his record was based upon a single inadequately described, small, damaged female which Hoyle intimated could be merely a juvenile of R. patagonica Smith which was taken in the same set.

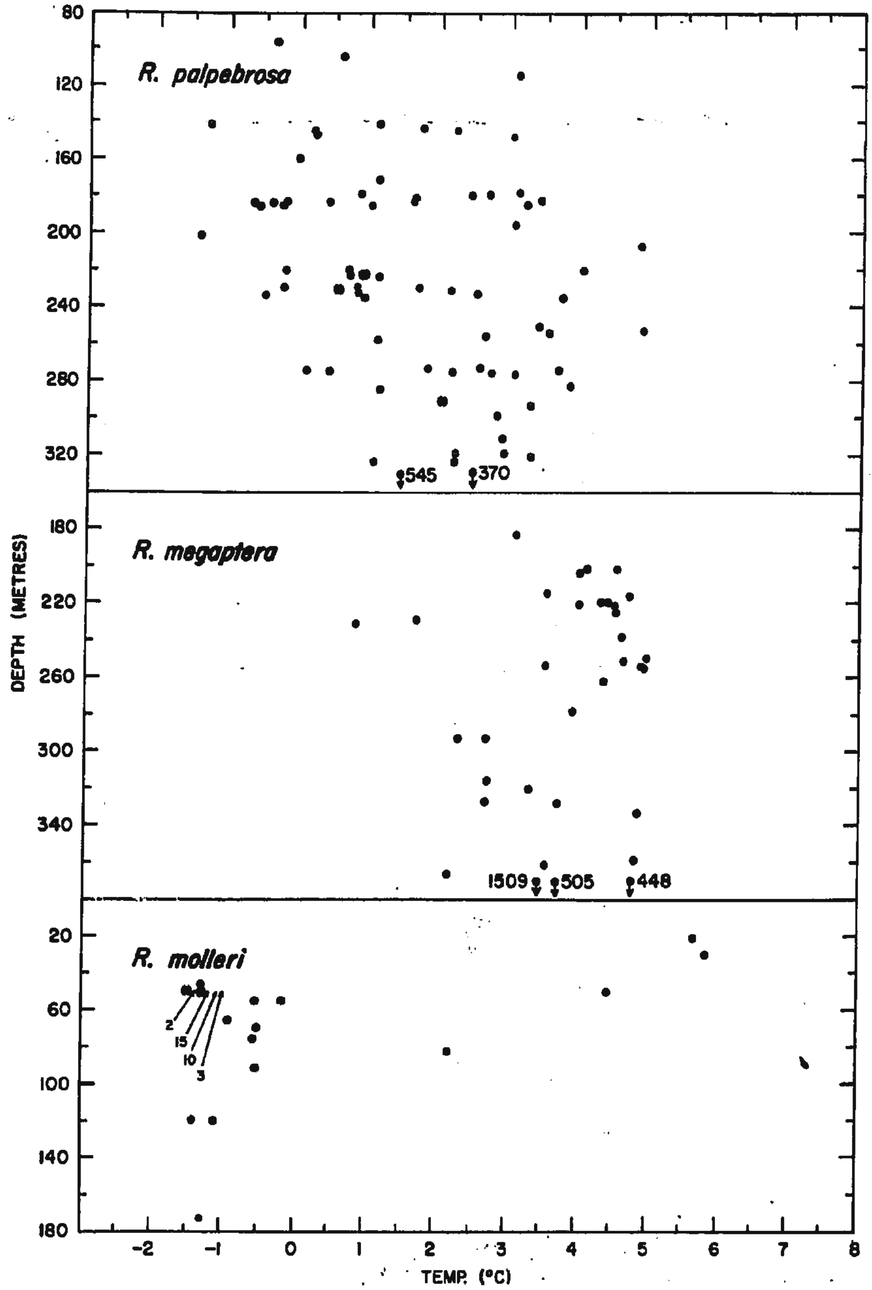

Fig. 3. Temperature-depth distribution of <u>Rossia</u> specimens from the Arctic and Atlantic examined by the author. As an indication of bias of fishing effort (in the area where <u>R. palpebrosa</u> and <u>R. megaptera</u> were collected) the 4917 sets made by the <u>A. T. Cameron</u> 1958-66 and the <u>Investigator II</u> 1956-65 have been analyzed for depth. Percentages of sets (nearly all of one-half hour duration) at each range of mean depths are as follows: 21-50 fath (37-91 m): 27.3; 51-100 fath (93-183 m): 25.8; 101-150 fath (185-274 m): 22.8; 151-200 fath (276-366 m): 15.9; 201-250 fath (368-457 m): 2.8; 251-300 fath (459-549 m): 2.3; 301-400 fath (551-732 m): 2.5; >400 fath (732 m): 0.5.

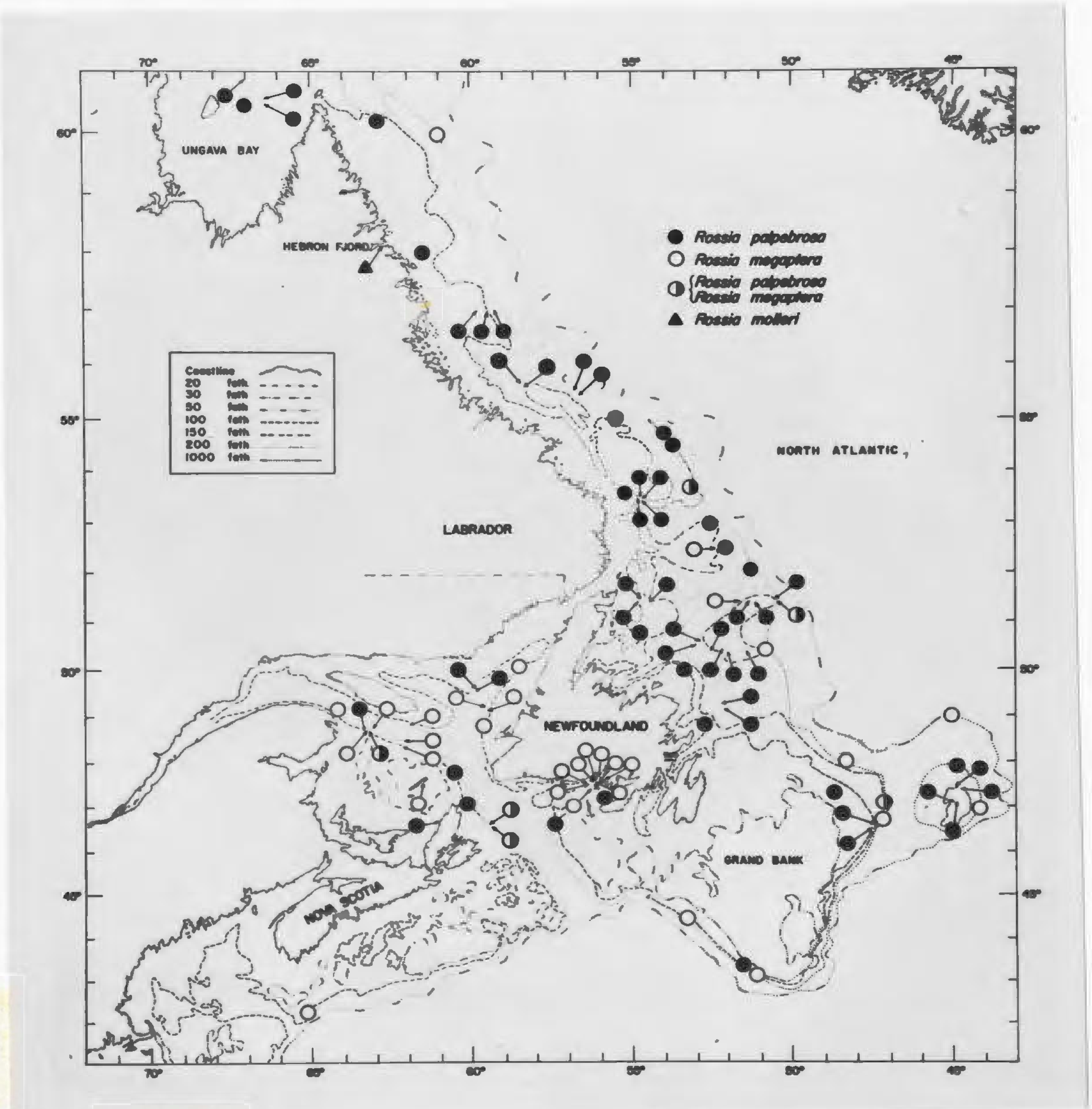

Fig. 4. Map of the Canadian Atlantic showing collection sites for Rossia specimens examined by the author and place names mentioned in the text.

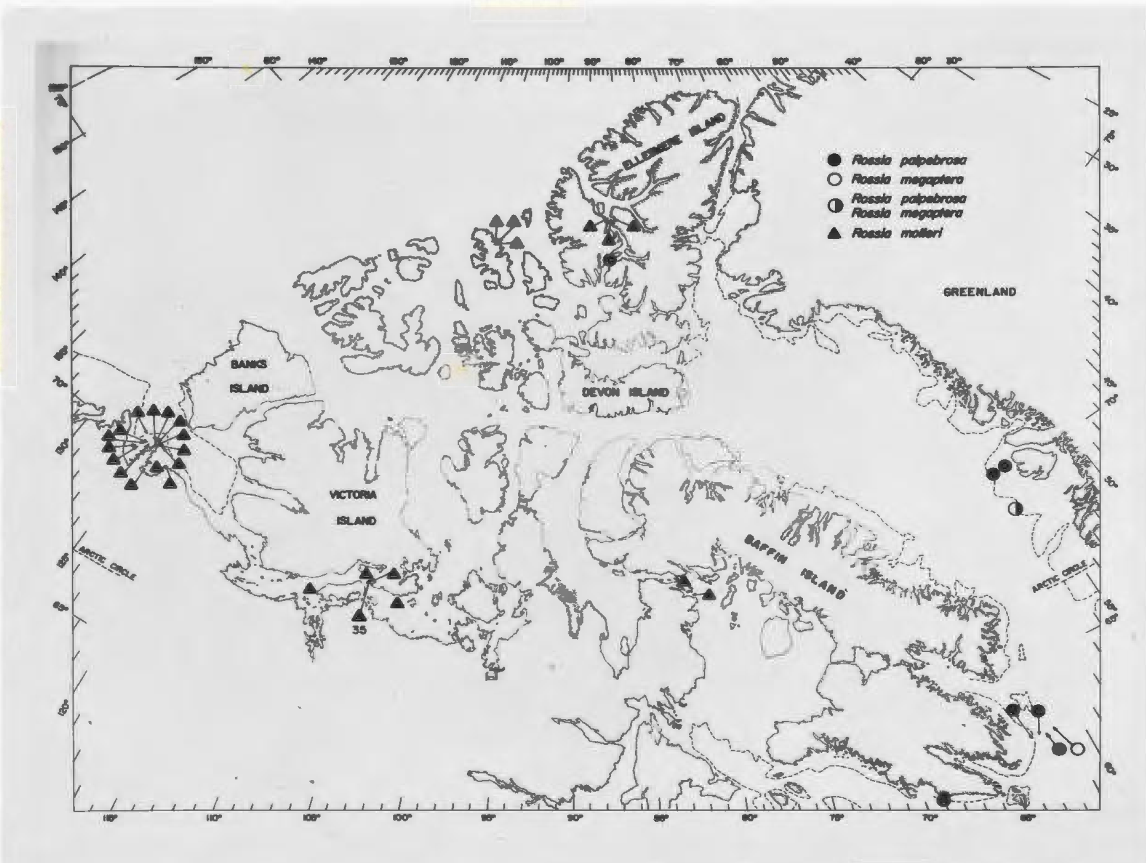

Fig. 5. Map of the Canadian Arctic showing collection sites for Rossia specimens examined by the author and place names mentioned in the text.

Rossia (Rossia) megaptera Verrill, 1881

Figure 6

Rossia megaptera Verrill, 1881, p. 349, pl. XXXVIII, fig. 1, pl. XLVI, fig. 6. - Joubin, 1902, p. 133, fig. 33.

Rossia macrosoma non Delle Chiaje. Pfeffer, 1908, p. 40, figs. 38-43 (part.).

Rossia caroli non Joubin. Chun, 1913, p. 12. - Joubin, 1924, p. 47.

Material: 75 specimens (Appendix I, Table II).

Description: Mantle short, saccular, longer than wide ($\overline{MWI}$ = 82.5). Anterior margin sinuous, bluntly produced dorsally and excavated ventrally.

Fins large ($\overline{FLI}$ = 71.6), broad ($\overline{FWI}$ = 159.7), with free anterior lobes reaching mantle margin. Both mantle and fins with rather flabby consistency characteristic of the deep water Rossia.

Head large ($\overline{HLI}$ = 73.1) and wide ($\overline{HWI}$ = 85.4) with prominent protruding eyes.

Funnel with broad base; long and tubular, nearly reaching bifurcation of ventral arms. Funnel organ large and fleshy. Dorsal member strongly shouldered. Ventral pads boomerang shaped, considerably wider posteriorly. Valve small, situated near funnel mouth.

Anal palps small and blunt, without blades. Pair of papillary organs present in males, one on either side of rectum just ventral to excretory pores.

Arms lengths generally in order 3.4.2.1 or 3.2.4.1, third pair always the longest. Sessile arm suckers in two rows, globular, with smooth, round apertures. In males, suckers on all but dorsal arms larger than in females.

Dorsal arms of males hectocotylized with expanded ventral bordering membranes extending full length of arms. Low scalloped protective membranes present on all arms.

Interbrachial webbing low, lacking between ventral arms. Low dorsal web present on arm IV, extending from shallow tentacular sheath.

Buccal membrane low; arms I, II with dorsal supports, III, IV with ventral supports. Supports of both dorsal and ventral arms united at base.

Tentacles long, flattened orally and rounded aborally, with moderately expanded clubs. Dorsal web originates in carpal region; widest at the proximal margin of club, appearing as a prominent semi-oval in this portion, thereafter attenuating and terminates at about midpoint of club. Well-developed ventral protective membrane. Club suckers with entire margins, in 6-7 rows.

Color purplish on muddy white background. Chromatophores more densely distributed dorsally.

Type: Not located. Perhaps in the Yale Peabody Museum.

Type locality: Off the southern coast of Newfoundland in 150 fathoms.

Discussion: Pfeffer (1908) regarded *R. megaptera* as a synonym of *R. macrosoma* Delle Chiaje while Grimpe (1933) thought this doubtful, believing *R. megaptera* might be poorly preserved *R. palpebrosa*.

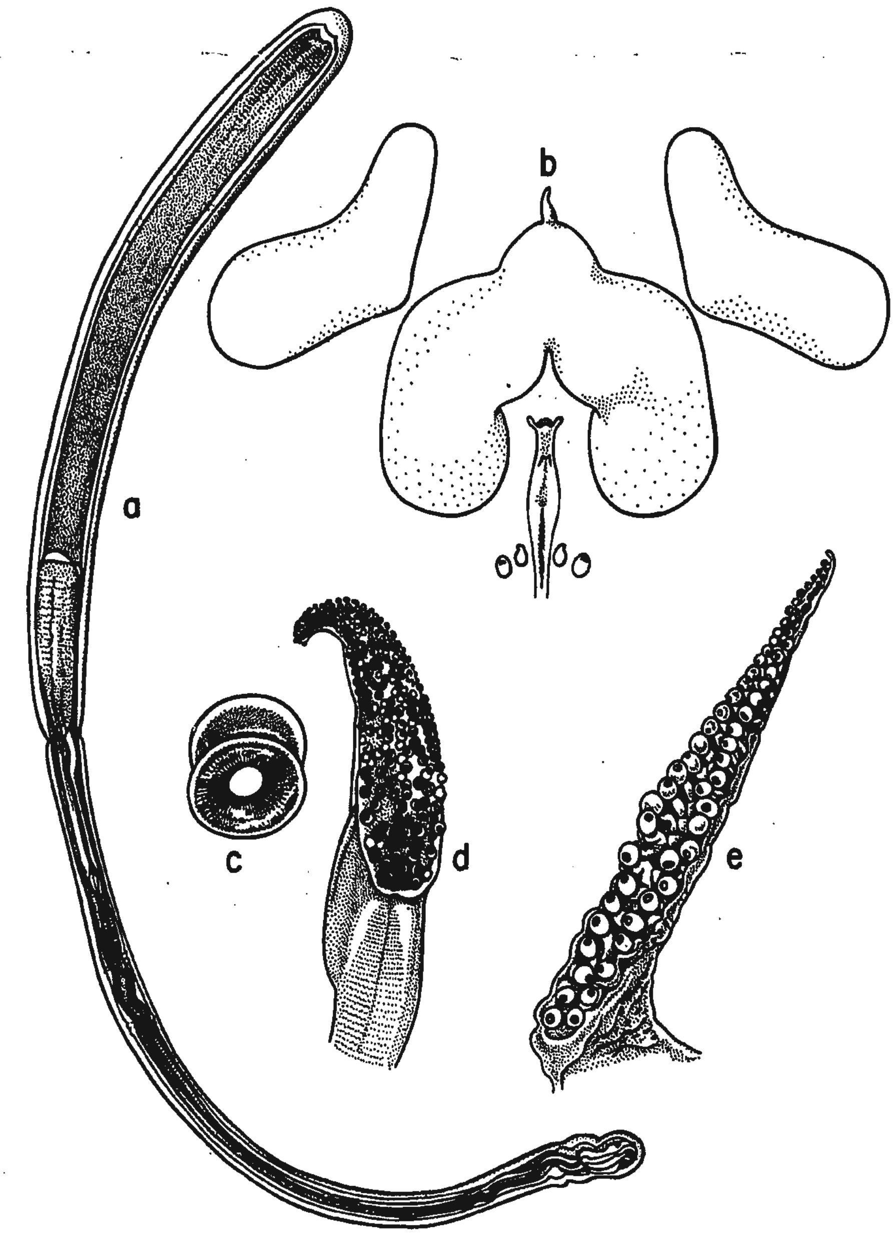

Fig. 6. Rossia megaptera: a, spermatophore (Specimen R-58); b, funnel organ, anal palps and anal papillae (Specimens R-29, 57); c, club sucker (Specimen R-16); d, club (Specimen R-16); e, hectocotylized arm (Specimen R-57).

The record of Chun (1913) from south of the Grand Bank and that of Joubin (1924) from south of Halifax for R. caroli Joubin undoubtedly relate to specimens of R. megaptera. That Joubin was unfamiliar with this species is obvious from his statement (1920) that comparison of his R. caroli with R. megaptera was useless since the species differ so much at first glance. R. megaptera seems most closely related to R. caroli (but the club of the latter is attenuate and unexpanded, with about 10 rows of suckers and a small shallow dorsal web). It is possible that further investigation may reveal this species to represent an eastern Atlantic race of R. megaptera or that the two are members of a superspecies complex.

Adam (1960) has compared the descriptions of R. bullisi Voss and R. caroli, noting the similarity. However the funnel organ of R. bullisi is of the small, simple inverted V shaped type, as figured by Voss (1956, p. 102, fig. 2d), not large and shouldered as in R. caroli and R. megaptera. Also the spermatophore structure as figured by Voss (loc. cit., p. 102, fig. 2c) is somewhat different from that of the other two species.

Distribution: Western North Atlantic from West Greenland (Posselt, 1898; our records) to Massachusetts (as listed by Johnson, 1934). A collection made by the author extends the known distribution to the Hudson Canyon area. Depths where we collected this species ranged from 98 to 840 fathoms (179-1536 m, mean 299 m) with bottom temperatures 1.67 to 5.38°C (Fig. 3). Few hauls yielded both this species and R. palpebrosa (Figs. 4 and 5).

Rossia (Semirossia) tenera (Verrill, 1880)

Heteroteuthis tenera Verrill, 1880, p. 392.

Semirossia tenera (Verrill). Steenstrup, 1887 (1962, p. 206). - Grimpe, 1933, p. 503.

Rossia (Semirossia) tenera (Verrill) Voss, 1956, p. 99, figs. 1d, e.

Material: None.

Type: Not traced. Perhaps in the Peabody Museum, Yale University (fide Voss 1956).

Type locality: Off Newport, Rhode Island.

Distribution: On the basis of records from Spitzbergen and Northern Siberia (Lönnberg, 1899) Grimpe (1933) regarded R. tenera as "eine der wenigen Charakterformen der arktischen Meere". He predicted that the species would be found to occur in the West Greenland area as well as in the Canadian archipelago. If R. tenera were indeed an arctic species such a distribution would be expected. However Bruun (1945) did not record the species from Iceland nor did Muus (1962) record it from West Greenland or include R. tenera in his keys to the North Atlantic cephalopods of the ICES area (1963). Akimushkin (1963) doubts Kondakov's (1948) report of this species from the Kara Sea.

The only record of R. tenera from Canadian waters is that of Hoyle (1886). Hoyle's material reportedly consisted of a single small female specimen dredged south of Halifax (43° 03'N, 63° 39'W). I have examined the specimen and found it to be a male Rossia megaptera, in excellent condition, with prominently hectocotylized arms. The mantle had not previously been opened posteriorly enough to permit examination of the genitalia.

We have obtained no specimens from the Nova Scotian area and Dr. R. L. Wigley (U.S. Bureau of Commercial Fisheries, Biological Laboratory, Woods Hole), who has collected extensively off New England, reports (in litt.) no captures north of 40° 35'N.

R. tenera thus occurs in tropical-boreal areas off the eastern Americas ranging from New England to Florida and the Gulf of Mexico (Voss, 1956), Caribbean Sea and Brazil (fide Voss, 1956). *R. patagonica* Smith, 1881 (type locality 52° 20'S, 67° 39'W), regarded by Pfeffer (1908) to be synonymous with *R. tenera* was proposed by Thore (1959) to be a subspecies, thus extending the known distribution to antiboreal South America.

Rossia (*Rossia*) *molleri*[1] Steenstrup, 1856

Figure 7

Rossia Mølleri Steenstrup, 1856, p. 14.

Rossia mölleri Steenstrup, Joubin, 1902, p. 125, figs. 27-28. - Pfeffer, 1908, p. 35, figs. 28-29. - Grimpe, 1933, p. 500, fig. 1.

Material: 110 specimens (Appendix I, Table III).

Description: *Mantle* saccular, longer than wide ($\overline{MWI}$ = 74.5), rounded posteriorly. Anterior margin sinuous, bluntly produced antero-dorsally and excavated ventrally.

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[1] Emended in conformity with article 32(c)(i) of the International Code.

Fins large ($\overline{FLI}$ = 61.8) with large free anterior lobes not reaching mantle margin.

Head about as wide as mantle aperture ($\overline{HWI}$ = 67.0). Eyes of medium size. Olfactory tubercles large and prominent.

Funnel long and conical, reaching bifurcation of ventral arms. Valve semi-oval. Dorsal member of funnel organ large and fleshy with heavily, though variably, ridged square shoulders and pointed apical papilla. Ventral members arcuate, wider posteriorly. Anal palps large and bladed.

Arms long, third pair as long as mantle ($\overline{III}$ = 104.8). Aboral keeling on all but ventral arms which bear low dorsal web extending from tentacular sheath. Interbrachial webbing missing between ventral arms and low between others except between III-IV where tentacular sheath well developed.

Arm suckers in two rows, slightly larger in males ($\overline{SIs}$ = 3.6 in males, 3.3 in females), with entire round margins. Sometimes contraction in fixation gives appearance of oblique three rowed condition.

Dorsal arms of males hectocotylized with oral face widened and suckers considerably smaller, borne on raised truncated pedicels; thick ventral fold bordered by a membrane extends from about 3rd - 17th transverse sucker rows.

Tentacle stalks flattened orally and rounded aborally. Broad, well developed dorsal web commences slightly proximal to carpal region and extends to distal tip of club. Ventral protective membrane present, continued around proximal margin. Club suckers denticulate on entire margin with blunt flat-topped teeth. Proximal suckers in three rows, those of dorsal two being largest although those of ventral row large for the genus. Distal suckers smaller, in 4-5 rows.

Supports of dorsal and ventral arms united at base. Arms I, II with dorsal supports, III, IV with ventral supports.

Texture smooth. Chromatophores purplish, smaller and much more densely distributed dorsally.

Discussion: The enlarged tentacular suckers make this species quite distinctive. *R. mölleri* is apparently most closely related to *R. pacifica* (see following description and discussion under review of the genus). Ekman (1953) has pointed out that it is relatively common for a polar arctic species to have a closely related species in the Pacific arctic, their differentiation from a parent species being related to isolation imposed by the Tertiary elevations of the Bering Strait.

Type: Zoological Museum, Copenhagen University.

Type locality: North Greenland (likely NW Greenland - Muus, 1962).

Distribution: As reviewed by Grimpe (1933), *R. molleri* has been reported from West Greenland (see also Muus, 1962), Northeast Greenland, Spitzbergen, Jan Mayen and the Kara Sea. It is not reported at Iceland (Bruun, 1945).

It is likely that the record of Lönnberg (1899) for *R. tenera* from the Laptev Sea relates to a specimen of *R. molleri* (Odhner, 1923 has previously suggested that arctic records of *R. tenera* are probably misidentifications of *R. molleri*).

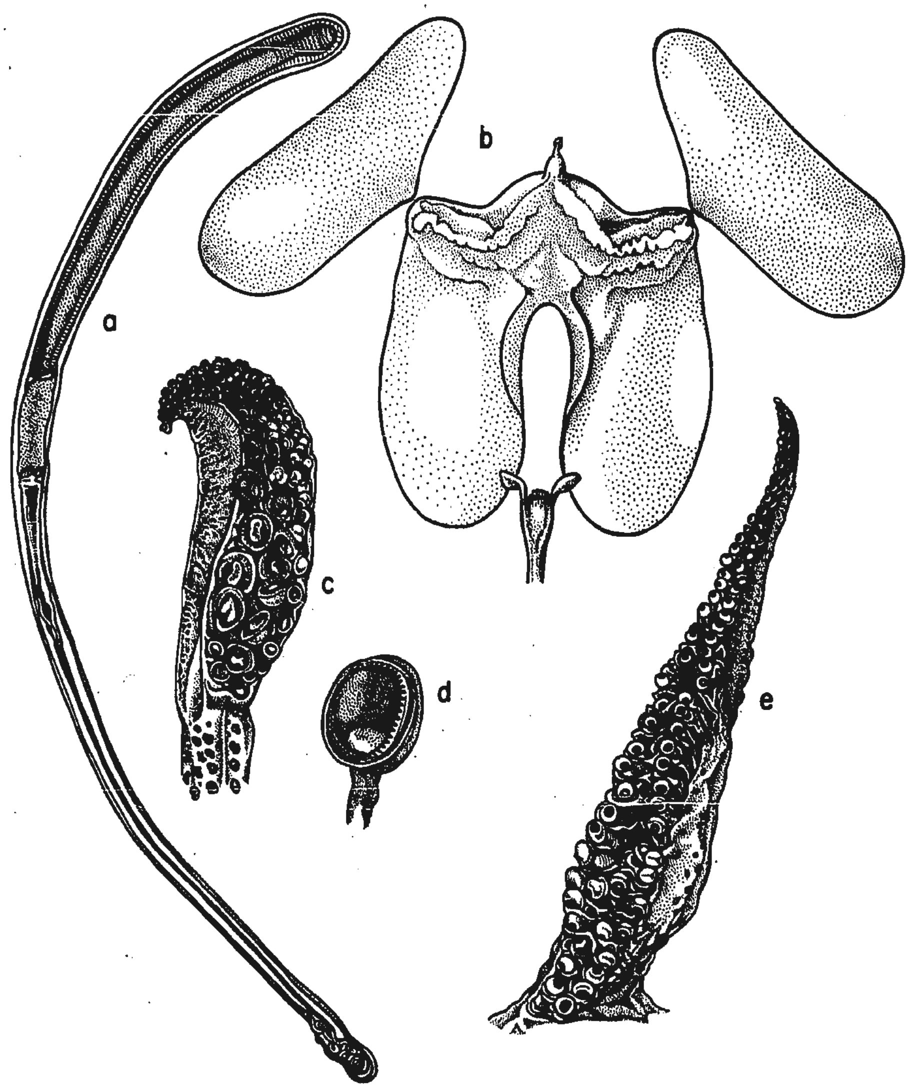

Fig. 7. Rossia molleri: a, spermatophore (Specimen RM-15); b, funnel organ and anal palps (Specimen RM-4); c, club (Specimen RM-1); d, club sucker (Specimen RM-1); e, hectocotylized arm (Specimen RM-4).

The species is notably absent in areas such as southern West Greenland, Iceland and the Barents Sea where admixture of Atlantic water with water of arctic origin occurs. The same situation obtains in the Chukchi Sea and on the north coast of Alaska where subarctic conditions prevail under Pacific influence (see MacGinitie, 1955 for work off Point Barrow). Thus all records fall within the arctic as delimited by Dunbar (1951). (It should be noted that most sampling off the North Siberian coast has been done in near shore waters where brackish conditions prevail.)

At West Greenland the southernmost definite record is from a walrus stomach in the Thule district (ca. 76° 30'N, 68° 35'W - Muus, 1962) although the subarctic area to the south has been heavily trawled. The species is not represented in the collections examined by the author from the *Calanus* expeditions to Hudson Bay, Hudson Strait, Ungava and Baffin Bays (for locations of fishing stations see Dunbar and Grainger, 1952; Grainger, 1954; Grainger and Dunbar, 1956; Grainger and Hunter, 1959). Nor was it obtained by otter-trawl explorations of the St. John's Biological Station in cruises of the *A. T. Cameron* to the Hudson Strait, Ungava Bay, east of Baffin Island, West Greenland and along the Labrador Shelf, although the arctic-boreal *R. palpebrosa* and the boreal *R. megaptera* were taken here (Figs. 4 and 5) (only *R. palpebrosa* in Ungava Bay). Admixture of Atlantic water occurs in all these areas although this may be slight in Frobisher Bay where it is masked by tidal turbulence (Dunbar, 1958). In Ungava Bay the Atlantic influence is more pronounced and the marine piscine and decapod crustacean faunas, for instance, are predominantly subarctic (Dunbar and Hildebrand, 1952; Squires, 1957).

Collections of R. molleri examined by the author include 108 specimens taken in 62 sets in the Canadian Arctic; these are from Slidre Fiord (Ellesmere Island), Foxe Basin, Isachsen (Ellef Ringnes Island), Cambridge Bay (Victoria Island), and Franklin and Darnley Bays (Amundsen Gulf). Bottom temperatures were negative in all but 5 sets (19 specimens) where specimens were taken inside the warm summer surface layer (Fig. 3). In 38 sets the bottom temperature was -1.00°C or below. Depths ranged from 17 to 250 (-270)[2] metres.

It is interesting then that two specimens of R. molleri were collected at a depth of 91 m in Hebron Fiord. This fiord, located at 58° 10'N on the northeast coast of Labrador (Fig. 4), is 28 miles long, with a sill depth of 59 m at the mouth and a depth of 255 m (Nutt and Coachman, 1956). During winter the water temperature is -1.75°C at all levels, rising in summer only to -1.68°C at 250 m and -1.00°C at 100 m. The bottom waters thus remain an isolated pocket of high arctic environment during the summer and fall when negative temperatures down to 120 m disappear outside the fiord (Nutt and Coachman, 1956). The origin of the population in Hebron Fiord is inexplicable by such hypotheses as larval drift or migration from known arctic populations (see note on dispersal in the review of the genus, following section). It has long been known that in the late Pleistocene a marine arctic fauna extended southwards to the St. Lawrence River Valley (Dawson, 1893) and it appears that the

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[2]Indicating a range of 250-270 metres for the deepest set.

fiord population is a glacial relict. The nearest sites to Hebron Fiord where R. molleri was collected are northwestern Foxe Basin and Thule, at distances of about 800 and 1100 miles respectively.

R. molleri is the only known arctic endemic cephalopod.

Rossia (Rossia) pacifica Berry, 1911

Figure 8

Rossia pacifica Berry 1911, p. 591; 1912, p. 290, pl. XLI-XLII, pl. XLIII, fig. 1-4, pl. XLIV, fig. 1, 5. - Sasaki, 1913, p. 399; 1921, p. 188; 1929, p. 154, pl. XVI, figs. 3-6, text figs. 92-94. - Akimushkin, 1963, p. 156, fig. 45 (of translation, 1965).

Rossia pacifica diegensis Berry 1912, p. 293, pl. XLII, figs. 2-6, pl. XLIII, fig. 1.

Rossia borealis Sasaki 1913, p. 247.

Material: 54 specimens (Appendix I, Table IV).

Description: Mantle broad and saccular, longer than wide ($\overline{MWI}$ = 76.6). Anterior margin sinuous, broadly produced antero-dorsally and excavated ventrally below funnel.

Fins large ($\overline{FLI}$ = 62.8) and muscular, with free anterior lobes not reaching mantle margin.

Head narrower than mantle ($\overline{HWI}$ = 69.4). Eyes with crescentic lids, lower one free. Olfactory tubercle fairly prominent.

Funnel stout and conical, extending anteriorly to bifurcation of ventral arms. Valve small, anteriorly situated. Funnel organ large and fleshy; dorsal member shouldered, with an apical papilla; ventral members sharply angled, broader posteriorly.

Anal palps large and bladed.

Arms long, longest about equal in length to mantle ($\overline{III}$ = 111.2). Order variable but 3.2.4.1 most common. Ventral pair with dorsal keel extending from tentacular sheath to arm tip. Interbrachial webbing low, missing between ventral arms. Weakly developed protective membranes present on all arms.

Suckers larger in males ($\overline{SIs}$ = 6.4) than females ($\overline{SIs}$ = 4.2), in 2 rows though sometimes crowded into 3-4 rows especially near base. Apertures round and entire.

Dorsal arms hectocotylized with suckers smaller than on other arms, truncated bases giving pallisaded effect. Ventral membrane thick and swollen, overlying groove bordered by secondary ventral membrane.

Tentacle stalks flattened orally, rounded aborally. Broad dorsal web originates proximal to club and continues to distal tip, lacking expanded flap. Low ventral protective membrane extends around proximal margin. Club suckers in four rows proximally, increasing to about six rows distally; largest dorsally. Blunt, flat-topped teeth on entire margin.

Texture smooth. Color violet; chromatophores small and closely distributed dorsally, larger and more diffuse ventrally.

Type: United States National Museum 214323. No longer extant.

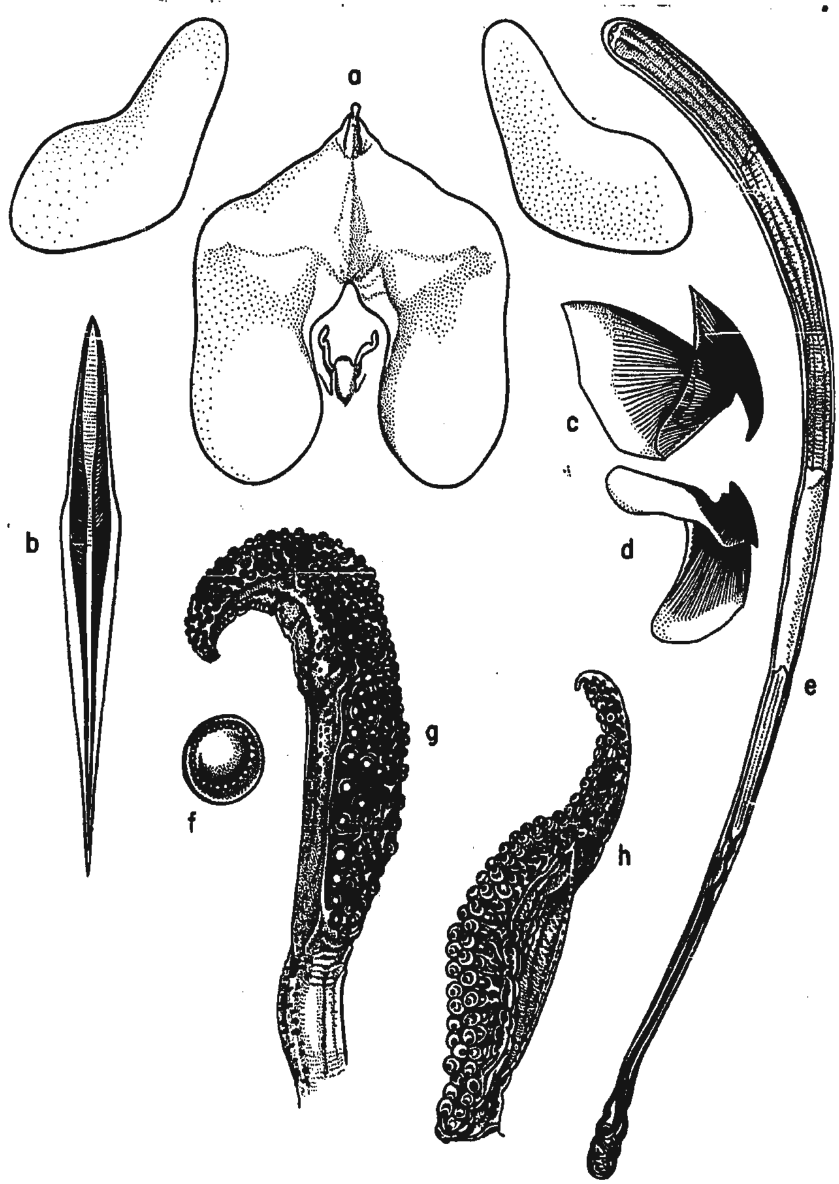

Fig. 8. Rossia pacifica: a, funnel organ and anal palps (Specimen RP-4); b, gladius (Specimen); c, upper mandible (Specimen RP-3); d, lower mandible (Specimen RP-3); e, spermatophore (Specimen RP-3); f, club sucker (Specimen RP-3); g, club (Specimen RP-1); h, hectocotylized arm (Specimen RP-2).

Type locality: Albatross station 4233, Behm Canal, Alaska.

Discussion: Sasaki (1913) reported a new species, *R. borealis*, from Hakodaté, Japan. However in his monograph (1929) he regarded this as a synonym of *R. pacifica*. On reading his discussion (loc. cit., p. 157), I am inclined to agree.

Berry's (1912) subspecies *diegensis* was based on three small specimens from off San Diego. He reported that, "They differ in being uniformly much smaller, in every way more slender and delicate, the fins relatively larger, and the suckers of the sessile arms borne predominantly in two rows, only here and there (notably in the case of the hectocotylized arms) assuming the four-rowed condition". Measurements and indices of his three specimens are listed (Table I). These are all well within the ranges of our material (Fig. 9) and several are even close to the means given.

Sasaki (1929) reported specimens up to 8 cm mantle length although the largest specimen Berry mentions is 4.8 cm long and our largest specimen measures 5.8 cm.

Sasaki (1929) also described and figured (p. 155) longitudinal ovate apertures sometimes occurring in the brachial suckers, especially in males. This was not noted in any of our specimens.

Distribution: The species is arctic boreal. Akimushkin (1963) presents a figure showing the distribution of *R. pacifica* in the Northwest Pacific, based on his own data as well as that of Sasaki (1921, 1929) and Kondakov (1941). On the Pacific coast of Japan records extend southwards on Honshu to Sagami Bay (Okutani, 1967). Thus it

Table I. Measurements (mm) and indices of Rossia pacifica diegensis (calculated from measurements given by Berry, 1912). Figures in brackets are based on the author's examination of the type.

	M	M	F type	
DML	22	23	32.5	(32)
MWI	72.7	60.9	58.5	(59.4)
HLI	-	-	-	(56.3)
HWI	-	-	-	(65.6)
FLI	68.2	65.2	64.6	(68.8)
FWI	140.9	134.8	135.4	(131.3)
FWIs	-	-	-	(37.5)
FPI	-	-	-	(25.0)
I	90.9	78.3	70.8	(68.8)
II	100.0	87.0	73.8	(75.0)
III	104.5	100.0	83.1	(81.3)
IV	90.9	91.3	72.3	(75.0)

apparently does not occur near that part of the coast washed by the warm Kuroshio Current. The species is found on both sides of the Sea of Japan southwards to SE Korea and to SW Kyushu (outside the Tsushima Strait in the East China Sea).

It is found in the Sea of Okhotsk, along the Kuril Islands and off southeastern Kamchatka to about 56°N. There are also two records shown from Mys Olyutorskiy in the Bering Sea. It occurs in the Aleutians and in the Eastern Pacific it ranges southwards to San Diego (Berry, 1912).

Sasaki's (1929) approximately 100 specimens were taken at depths ranging from 38 to 366 metres. Berry's (1912) 122 specimens were taken between 17 (-44) - 305 (-547) metres. Our material, for which depth data are available, was taken in 29-201 metres. Unfortunately, temperature data for the collections are not available.

Key to the species of Rossia in the Northwest Atlantic and Arctic

1. Proximal club suckers large, diameter about same as for brachial suckers. Dorsal member of funnel organ with ridges on shoulders . . . . . *Rossia molleri*

   Club suckers much smaller than brachial suckers. Dorsal member of funnel organ without ridges 2

2. Suckers in dorsal rows on proximal portion of club about 4 times diameter of those in ventral rows. Left dorsal arm only of males hectocotylized. . . <u>Rossia tenera</u>

Slight decrease only in sizes of club suckers from dorsal to ventral rows. Both dorsal arms of males hectocotylized. 3

3. Dorsal member of funnel organ small, inverted V shape. Anal palps large and bladed. No papillary organs present. . . . . <u>Rossia palpebrosa</u>

Dorsal member of funnel organ large and shouldered. Anal palps small, without expanded blades. Papillary organs present ventral to excretory pores in males. . . . . <u>Rossia megaptera</u>

Some taxonomic aspects of the gross morphology

Approximately 27 specimens of each species were selected for detailed measurements, the samples roughly stratified by mantle length. Log.-log. allometric equations were fitted to the data on body proportions but individual variability of animals in the same size groups was found to be so great that allomorphosis could be neglected for a general consideration of morphometric characters in the taxonomy of the genus. Indices of body proportions are treated statistically and compared in Fig. 9. It is evident that body proportions are of little use in the taxonomy of this group. These data

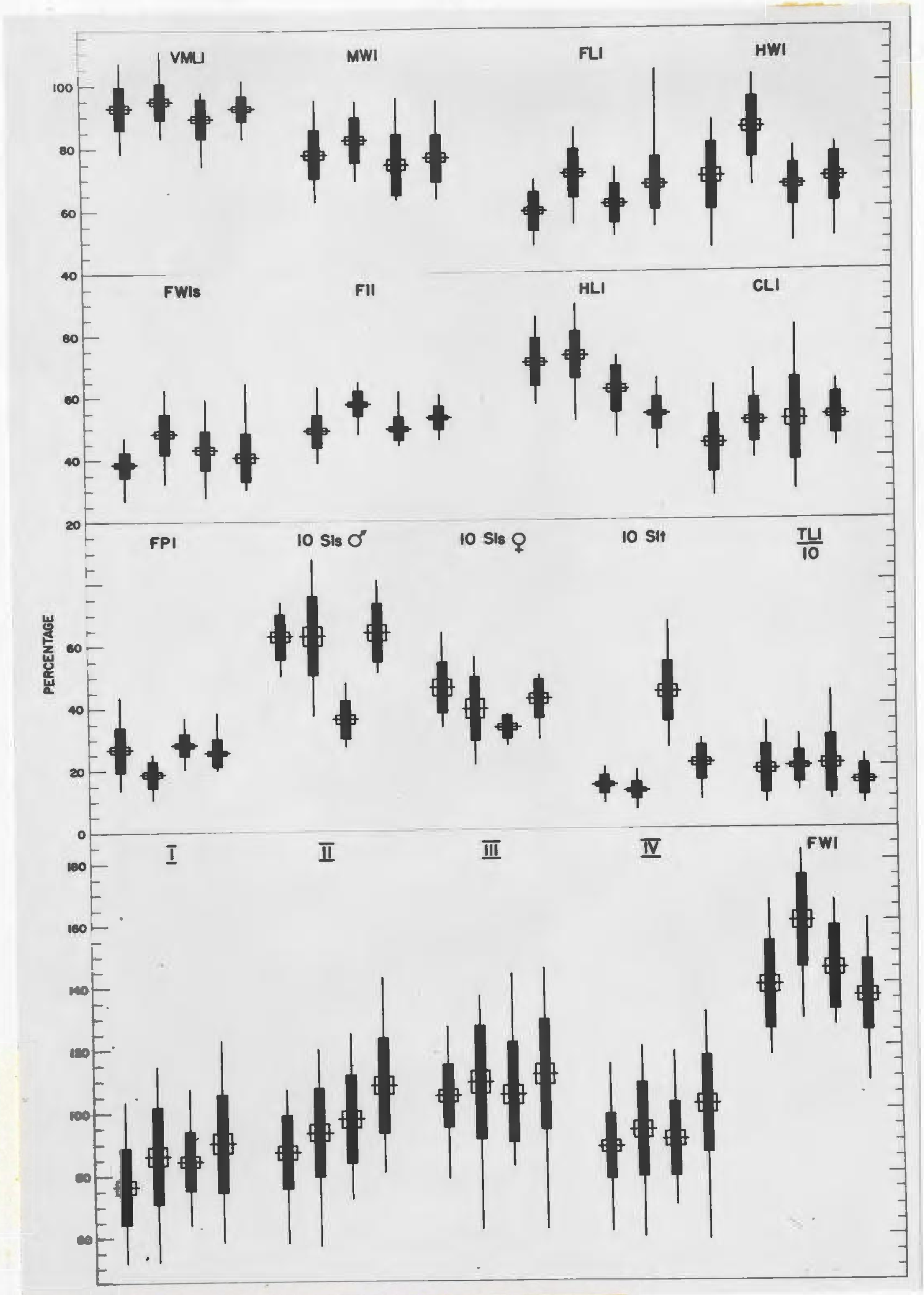

Fig. 9. Indices of species samples treated statistically, in the order (from left to right): R. palpebrosa, R. megaptera, R. molleri, R. pacifica. The range is represented by a vertical line, the mean by a horizontal line, one standard deviation on either side of the mean by a vertical bar, and one standard error of the mean on either side of the mean by an open rectangle. Measurements and indices of the individual specimens are given in Appendix II.

are presented here principally because of the traditional emphasis on morphometric data in cephalopod taxonomy.

Some general trends are however notable in this figure. For example, the head width index is generally higher for Rossia megaptera, as pointed out by previous authors. Also, the fin position index is smaller and the fin width index is larger, reflecting the generally larger size of the fins in this species. However there is considerable overlap between species for these indices.

Clearer separation is shown between indices of sucker diameters. Although the ranges overlap at least partially it is seen that the brachial suckers of R. molleri tend to be smaller than those of the other species. The tentacular suckers of R. molleri are much larger than those of R. pacifica, which are larger than those of R. palpebrosa and R. megaptera.

Body proportions are undoubtedly greatly affected by fixation and preservation and much variation can be attributed to this. The state of contraction or relaxation of the animal at fixation also affects the disposition of the brachial suckers, which, in contracted specimens, often appear to be in 3-4 rows rather than in the normal 2. This artificial character has been used in generic diagnoses.

Of the taxonomic characters investigated the following were found to be most useful:

1. Configuration of the dorsal member of the funnel organ. While subject to some alteration by fixation, these organs are quite distinctive among the species studied. The partly sympatric R. palpebrosa

and _R. megaptera_ are most easily distinguished by this character, that of the former being a simple inverted V shape while in the latter it is large and shouldered. Some variable folds caused by fixative are found in all species but the thick dorsal member of _R. molleri_ is consistently, though variably, ridged on the shoulders.

2. Size and shape of the anal palps. These are large and bladed in all but _R. megaptera_ where they are small and blunt. This again is a useful character in the separation of _R. palpebrosa_ and _R. megaptera_.

3. Structure of the club. Features useful here include size, distribution and dentition of the suckers and the shape and extent of the dorsal web. The clubs of _R. molleri_ and _R. pacifica_ are quite distinctive, the former especially because of the extremely large proximal suckers. _R. palpebrosa_ and _R. megaptera_ show less difference in club structure with only slight differences in sucker size and web shape.

4. Beaks. The lower beak of _R. pacifica_ shows a marked protuberance on the shoulder, a feature not indicated in the other species.

5. Sexual characters in the male. These include the structure of the hectocotylus and spermatophore and the presence of anal papillae. While hectocotylization is nearly similar in _R. palpebrosa_ and _R. megaptera_, somewhat different structures are found in the other two species; the hectocotylus and anal papillae are considered further in the next section. The spermatophores of all species are distinctive.

Preliminary review of the genus

Pending a comprehensive generic revision, conservatism is undoubtedly the most propitious approach to the systematics of this group. When the interrelationships of the various forms are better understood, possibly, a phylogenetically more acceptable classification can be derived therefrom. Nevertheless some steps can be taken here to stabilize nomenclature and re-evaluate the basis of subgeneric divisions currently employed.

The subgenus *Franklinia* was erected by Norman (1890) for *R. glaucopis* and defined by the presence of only two rows of brachial suckers. "Besides the species here described the following will fall into this subgenus: *R. megaptera* Verrill, and apparently *Heteroteuthis tenera* Verrill" - followed by a consideration of *R. glaucopis* (loc. cit., p. 470). I construe this to indicate that Norman regarded *R. glaucopis* as the type of his new subgenus. Designation of *R. tenera* would result in submergence as an objective synonym of *Semirossia* Steenstrup. Hoyle (1910) designated *R. glaucopis* as type species of *Franklinia* and submerged it under *Rossia*.

Grimpe (1922) subsequently proposed *Allorossia* as a replacement name for *Franklinia* Norman which was preoccupied by *Franklinia* Blyth 1863 for a bird genus. The group has recently been reviewed by Mangold-Wirz (1963).

Some authors (e.g. Jaeckel, 1958; Muus, 1963) have favored elevation of *Allorossia* to generic status. However since *R. glaucopis* Lovén is here shown to be a junior synonym of *R. palpebrosa* Owen and since the nominate subgenus must bear the same name as the genus, the nomen Allorossia Grimpe is shown to be an objective synonym of Rossia Owen.

For purposes of discussion the subgenus Rossia is here considered to comprise half of the known species: R. palpebrosa Owen (type, by monotypy), R. megaptera Verrill, R. caroli Joubin, R. macrosoma (Delle Chiaje), R. bullisi Voss, R. tortugaensis Voss, R. mollicella Sasaki, R. brachyura Verrill, R. pacifica Berry, R. molleri Steenstrup.

In all of these species (except for R. tortugaensis in which Voss (1956) reported no apparent sign of hectocotylization in the single male examined and R. brachyura of which no male specimen has been reported) both dorsal arms of the males are hectocotylized with expanded ventral bordering membranes. R. pacifica has a secondary ventral membrane as well and the hectocotylus structure appears to represent an intermediate stage between the R. palpebrosa and R. molleri types. The thickened fold found in R. molleri could be derived from the condition found in R. pacifica by enlargement of the inner ventral membrane. While the suckers on the hectocotylized arms are uniformly small throughout and are distributed in two rows, the suckers on the other sessile arms are enlarged in males and may be artificially crowded into 3-4 rows in some species. The club suckers are in approximately 5-16 transverse rows.

When Berry (1918) erected the subgenus Austrorossia he characterized it as follows:

"(1) The tentacle club is unusually long, more or less coiled, and armed with an immense multitude of infinitesimal suckers.

(2) The suckers on the sessile arms are in two rows throughout.

(3) Some of the suckers on all the sessile arms of the males suffer sexual modification, i.e. enlargement.

(4) The hectocotylized arms of the males are characterized not only by modifications in the size of certain of the suckers as above, but (in the type species at least) by the presence of a pocket-like gland on the outer surface of the arm."

Austrorossia can here be considered to include: R. australis Berry (type by original designation), R. mastigophora Chun, R. enigmatica Robson, R. bipapillata Sasaki, R. antillensis Voss.

These species all have numerous rows of club suckers (24 reported in R. bipapillata, 30-40 in the other species).

Both dorsal arms of the males are hectocotylized by the presence of a ventral fleshy pad and several enlarged pairs of suckers. However the males of R. bipapillata are unknown and the fleshy pad was not mentioned by Chun in the single small male specimen he examined. (He did describe, 1913, p. 408, and figure, pl. 63 fig. 1, irregularly enlarged hectocotylus suckers.) It must be noted here that R. molleri also has fleshy ventral pads on the hectocotylized arms although these arms have no enlarged suckers. Also this species has only five rows of club suckers, including the largest found in the genus, compared with those in the above listed species which are the smallest.

Voss (1955) mentioned that a papillary organ occurs on either side of the rectum in most of these species. Chun (1913) reported two pairs in R. mastigophora, one just posterior to the anus and the other ventral to the excretory pores. A pair of papillae has also been reported in R. bipapillata and R. antillensis but Berry (1918) made no mention of their presence in R. australis. R. enigmatica has a large flat pore on each side of the rectum (Voss, 1962). However papillary organs are also here reported, ventral to the excretory pores, in males only of R. megaptera. Although again previously unrecorded, the author also found them in males only of R. bullisi and R. caroli (the latter of which the author has examined male specimens only).

Voss (1962) has suggested the possibility that all members of this subgenus may represent merely geographical variants of a single species. If they are monophyletic in the strictest sense and have speciated since invading their present deep-water habitat, whether they comprise an Artenkreis or Rassenkreis is a matter to be resolved when more complete information is available on geographic distribution and variation.

The subgenus Semirossia was erected, as a genus, by Steenstrup (1887). Hoyle (1910) designated H. tenera Verrill as the type species of Semirossia.

Semirossia includes R. tenera (Verrill), R. patagonica Smith, R. equalis Voss, R. (Semirossia) sp. Voss 1955.

In these species the left dorsal arm only of the male is hectocotylized as follows: an expanded ventral membrane extends for most of the length of the arm. The proximal suckers are normal and are disposed in two rows, followed by a four-rowed condition of reduced suckers. In males of R. tenera and R. patagonica the suckers on the mid-portion of the other sessile arms are greatly enlarged but Voss (1950) reports that this condition does not obtain in R. equalis. The club suckers are in 6-8 rows.

Extended zoogeographic or phylogenetic consideration of the genus would be premature at this time since the systematics are in a state of flux and the cephalopod fauna of some areas (most notably South America) is still inadequately known. Nevertheless a few general observations may be made.

Of the 18 currently recognized species, 13 are found in the Atlantic, 11 of these in the North Atlantic; the only amphi-Atlantic species is the arctic boreal R. palpebrosa, while the boreal and tropical species are endemic to either the eastern or western side. Members of the subgenus Semirossia are reported only from the western Atlantic and off antiboreal South America.

In the Pacific Rossia is largely replaced by Euprymna. The fauna includes only six Rossia species, the only Semirossia being R. tenera patagonica which is the only species found in both the Atlantic and Pacific. R. molleri is the only known cephalopod endemic to the arctic.

No Rossia species have been reported from oceanic islands (for the Marshall Islands and Bermuda see Voss 1954, 1960; for Hawaii see Berry, 1914). Since the eggs are demersal and the newly hatched young non-planktonic, dispersal is limited by the locomotive powers of the juvenile and adult and is hence fairly effectively restricted to areas where breeding is possible. This is strikingly reflected in the distribution patterns.

Notes on biology

In this section the general biology of all species is considered together, comparisons being made where warranted by the data. Temperature-depth distribution has already been discussed in the systematic account.

Maturity

Females were classified as mature when clear eggs were present in the ovary, maturing when the most advanced ova were clearing and immature when only opaque ova were present (Fig. 10). Members of the genus are polytelic with ova ripening in small clusters, each individual apparently spawning several times. Mature specimens contain ova of all stages of maturity, the most mature eggs found in an individual being 28 (out of a total of 366, see Table II). (Note that in mature animals some of the ova become misshapen and elongated because of the great distension of the ovary.) There is a possibility that some females classified as maturing had recently deposited eggs and the most advanced ova present are still clearing (e.g. see Fig. 11, largest maturing R. megaptera). Larger females lay slightly larger eggs (Fig. 12). Ripe ovarian eggs are largest in the arctic R. molleri (7.4-8.5 mm) followed by the arctic-boreal R. palpebrosa (5.9-8.1 mm); those of the other species are slightly smaller (5.6-7.5 mm in R. megaptera and 5.7-7.0 mm in R. pacifica).

Ova counts were made on 17 specimens. These ranged from 125 to 545. Fecundities of mature specimens listed (Table II) may not be accurate because of the possibility of previous spawning (e.g. see RM-93 which has few remaining opaque ova). Data presented are not

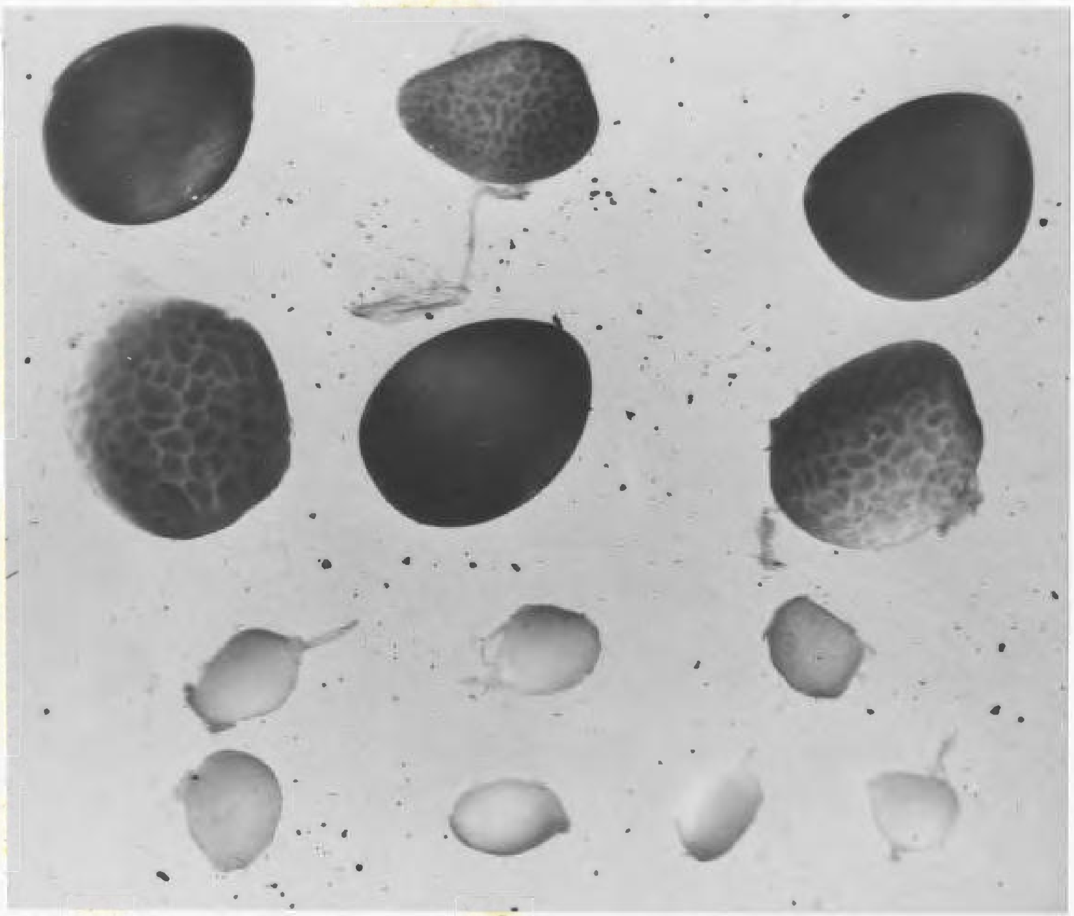

Fig. 10. Stages in the maturation of the ova of Rossia mölleri: Clear and clearing ova from Specimen RM-87 and opaque ova from Specimen RM-95 (some of which are starting to clear).

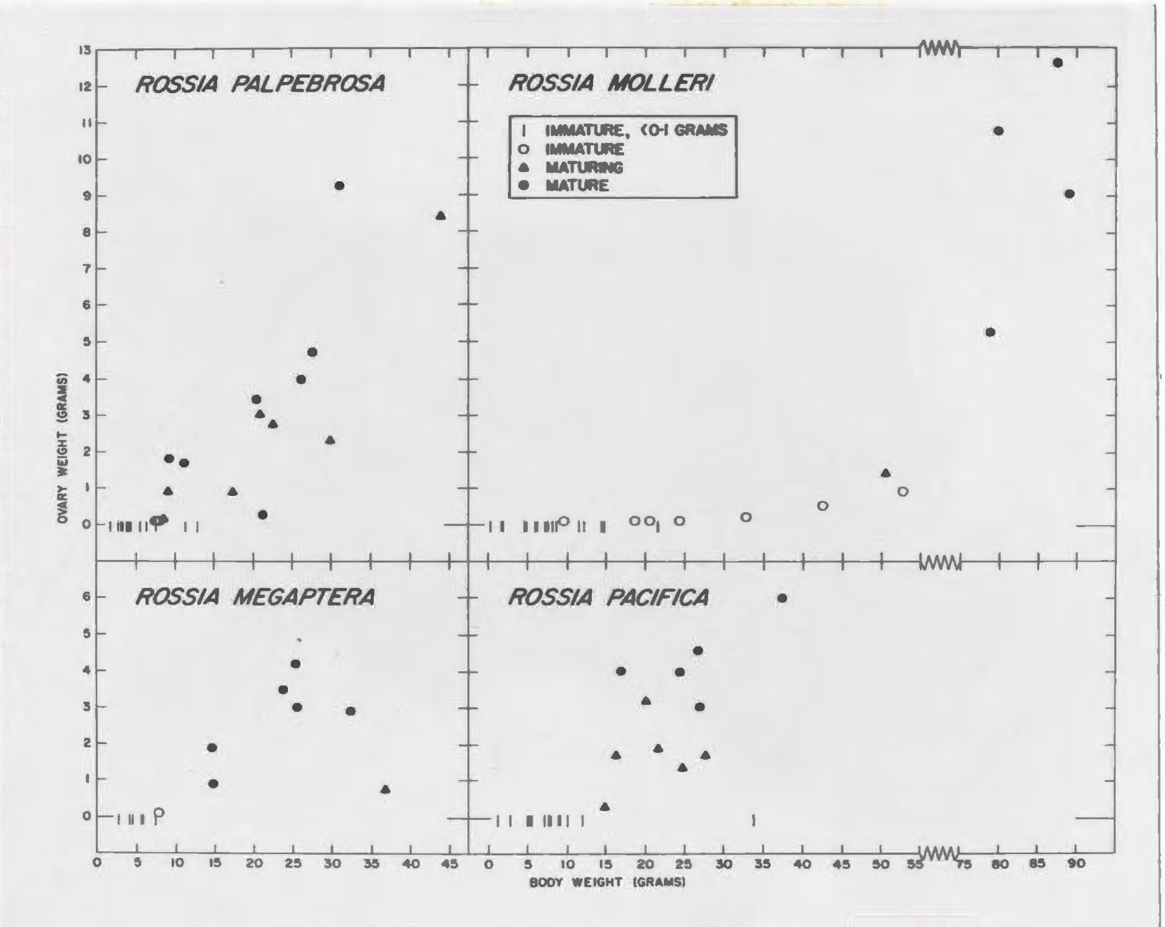

Fig. 11. Ovary weight - body weight relationship for R. palpebrosa, R. molleri, R. megaptera and R. pacifica.

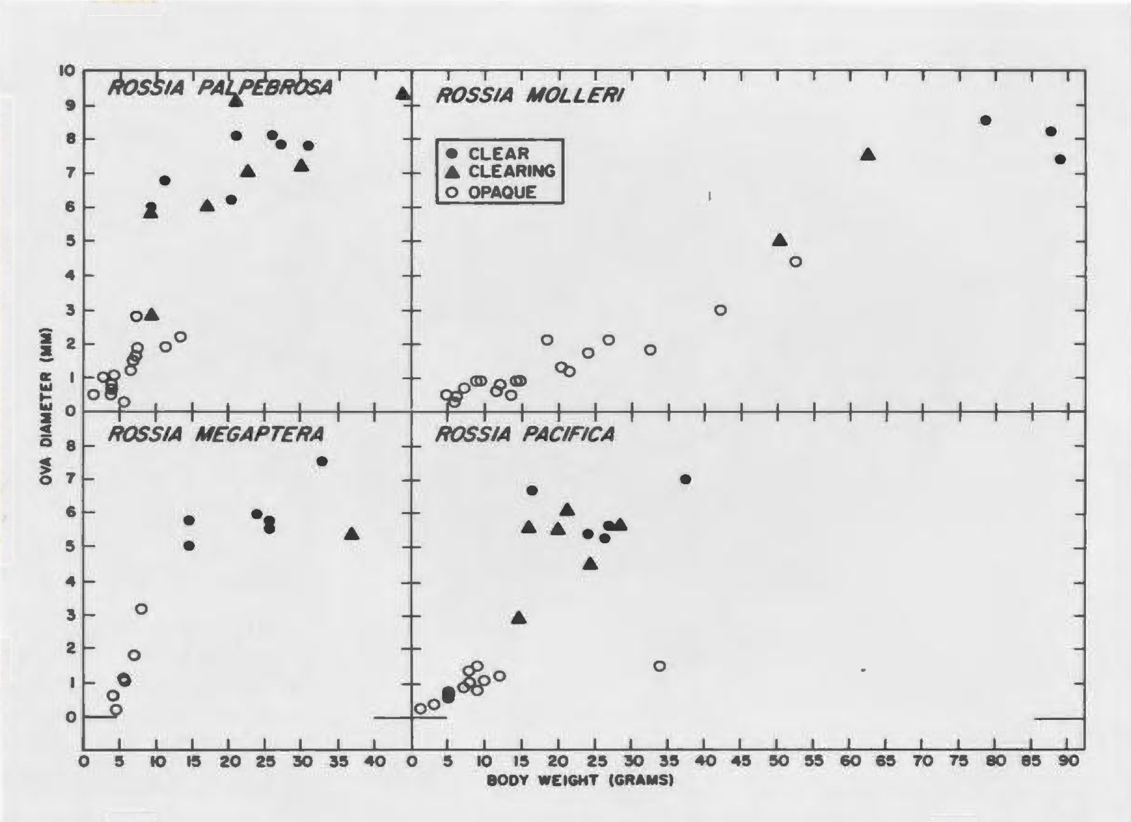

Fig. 12. Long diameters of largest, most mature, ova for R. palpebrosa, R. molleri, R. megaptera and R. pacifica, related to body weight.

sufficient to permit comparisons among species.

Male specimens were classified as mature when spermatophores were present in the spermatophoric sac. The testis is small, even in mature specimens (Fig. 13). Maturation does not result in any enlargement and there is evidence of regression in size after the spermatophores are formed. In R. molleri (Fig. 13) the larger matures have a smaller testis than many of the smaller matures and immatures; this species has by far the largest testis of the species investigated (up to 1.1 g, 7.5 percent body weight). Unlike in the teuthoids, the spermatophoric organ is considerably larger than the testis. Although no data are tabled here, spermatophore lengths were found to be related to size of the specimen, as has been found general in cephalopods.

Growth

Males generally mature at smaller sizes and do not grow as large as the females. This has also been found for R. macrosoma and R. caroli (Mangold-Wirz, 1963a, b). The disparity is particularly pronounced in R. molleri where no maturing females were found as small as the largest males. The largest mature male was 33.3 g while mature females were 79.0 to 89.0 g. In R. pacifica mature males range from 6.8 to 39.4 g while mature females range upwards from 16.8 g. (No weights are available for the largest females, up to DML 57.7 mm.) In R. palpebrosa mature males range from 4.0 to 31.6 g while mature females are 11.4 to 48.6 g. Finally in R. megaptera mature males are 7.9 to 16.7 g and mature females 14.6 to 32.6 g (Figs. 14 and 15).

Table II. Ova diameters (mm) and counts for R. palpebrosa, R. megaptera, R. molleri and R. pacifica.

Species and Specimen No.	DML	Total wt.	Ovary wt.	Maturity	Size and number of ova: Mature	Clearing	Opaque	Opaque elongate	Ova count
	(mm)	(g)	(g)						
R. palpebrosa									
R-96	41.3	44.1	8.4	maturing	8.5 (1)	3.6-9.8 (38)	0.6-5.4 (217)	-	256
R-157	42.1	30.1	2.3	maturing	6.2-7.4 (8)	2.8-6.9 (52)	0.5-7.0 (242)	2-5 (31)	333
R-153	29.6	13.5	<0.1	immature	-	-	0.3-2.1 (178)	-	178
R-132	25.0	8.6	0.2	maturing	-	3.0 (1)	0.4-2.9 (197)	-	198
R-37	25.0	7.6	0.1	immature	-	-	0.5-1.9 (175)	-	175
R. megaptera									
R-131	41.5	36.9	0.8	maturing	-	3.2-5.2 (15)	0.3-3.8 (320)	-	335
R-8	40.0	32.6	2.9	mature	5.5-7.5 (12)	2.6-6.6 (30)	0.3-4.1 (415)	2-4 (29)	486
R-29	33.5	23.7	3.5	mature	5.2-6.0 (17)	3.4-6.0 (32)	0.3-3.7 (243)	2-4 (30)	322
R-32	21.5	8.0	0.1	immature	-	-	0.3-3.2 (287)	-	287

Cont'd.

Table II. Cont'd.

Species and Specimen No.	DML	Total wt.	Ovary wt.	Maturity	Size and number of ova: Mature	Clearing	Opaque	Opaque elongate	Ova count
	(mm)	(g)	(g)						
R. molleri									
RM-96	67.4	87.7	12.6	mature	6.8-8.3 (18)	3.0-9.6 (72)	0.5-4.4 (333)	2-6 (71)	494
RM-93	60.1	79.0	5.2	mature	6.9-8.5 (22)	4.4-9.3 (35)	2.5-4.2 (6)	2-5 (62)	125
RM-95	54.5	52.6	0.9	immature	-	-	0.4-4.4 (278)	-	278
RM-100	47.1	42.5	0.5	immature	-	-	0.3-3.0 (355)	-	355
RM-74	35.2	20.5	0.1	immature	-	-	0.3-1.3 (405)	-	405
R. pacifica									
RP-15	49.1	37.4	6.0	mature	5.0-7.2 (28)	1.0-6.5 (61)	0.4-3.0 (253)	2-5 (24)	366
RP-7	41.0	27.9	1.7	maturing	-	2.5-5.0 (53)	0.4-2.8 (291)	-	344
RP-8	39.6	24.5	1.4	maturing	-	0.6-4.2 (66)	0.4-2.5 (479)	-	545

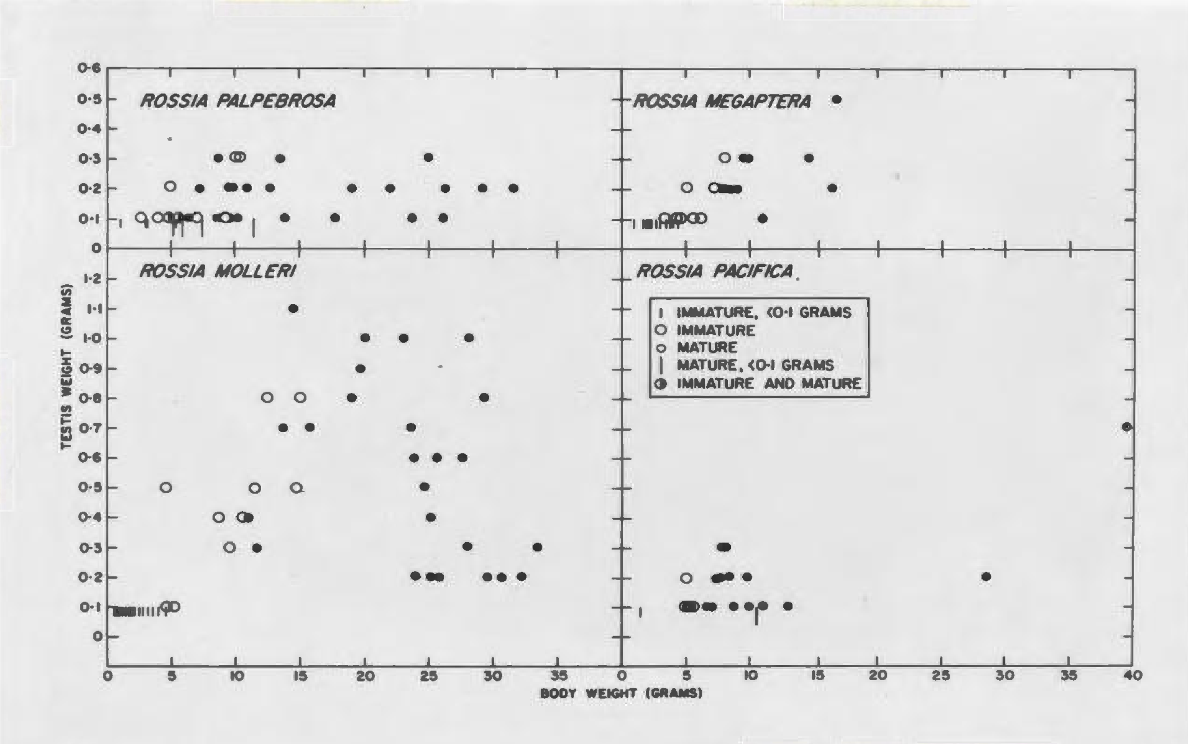

Fig. 13. Testis weight - body weight relationship for R. palpebrosa, R. megaptera, R. molleri and R. pacifica.

The arctic R. molleri is the largest and latest maturing of the species studied, followed by the arctic-boreal species, with the boreal R. megaptera the smallest. The largest specimens of R. palpebrosa were taken in the coldest environments.

Size and maturity were plotted against time of year to investigate the breeding season and attempt to discriminate size groups as an aid in estimation of age and growth (Fig. 16). Since all collections of R. molleri examined were made during the summer season (July-September, only 2 specimens in July) these were not plotted in the figure. The scarcity of specimens collected in winter is undoubtedly due to the operation of collecting vessels rather than absence of the species from the fishing areas.

Mature specimens of both sexes of both Atlantic species were taken during the whole collecting period. With R. pacifica no mature females were taken earlier than July although mature males occurred throughout the collecting season; this is perhaps only an artifact of sampling rather than a reflection of a restricted breeding season. Breeding probably occurs throughout most of or all the year in these three species. No well defined size groups can be seen in the data although some separation appears around the 12 g size. It should, however, be noted that the selectivity of the gear did not permit random sampling. Year round spawning has been reported in R. macrosoma (reviewed by Mangold-Wirz, 1963b) and suggested for R. caroli (Mangold-Wirz, 1963a).

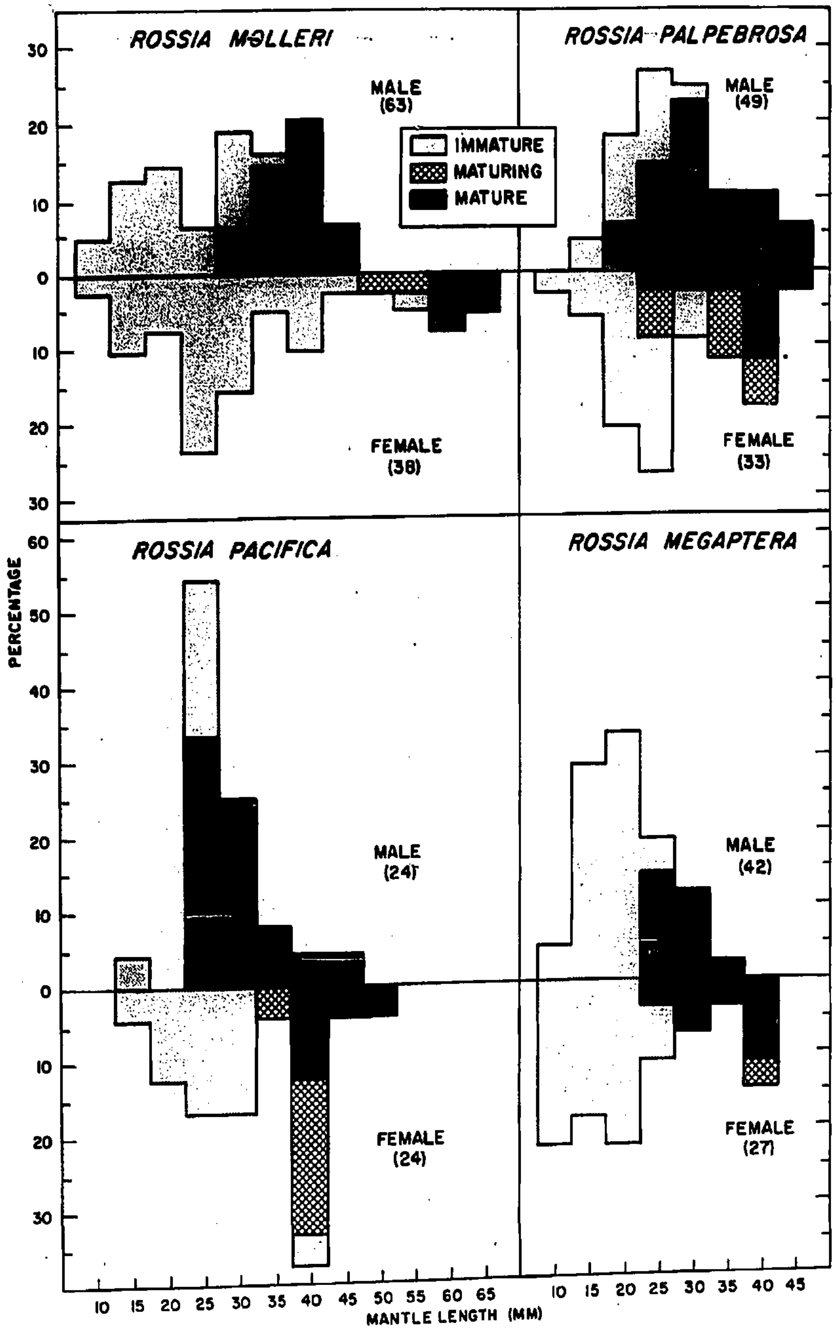

Fig. 14. Length histograms of R. molleri, R. palpebrosa, R. pacifica and R. megaptera examined. Numbers of specimens are indicated in brackets.

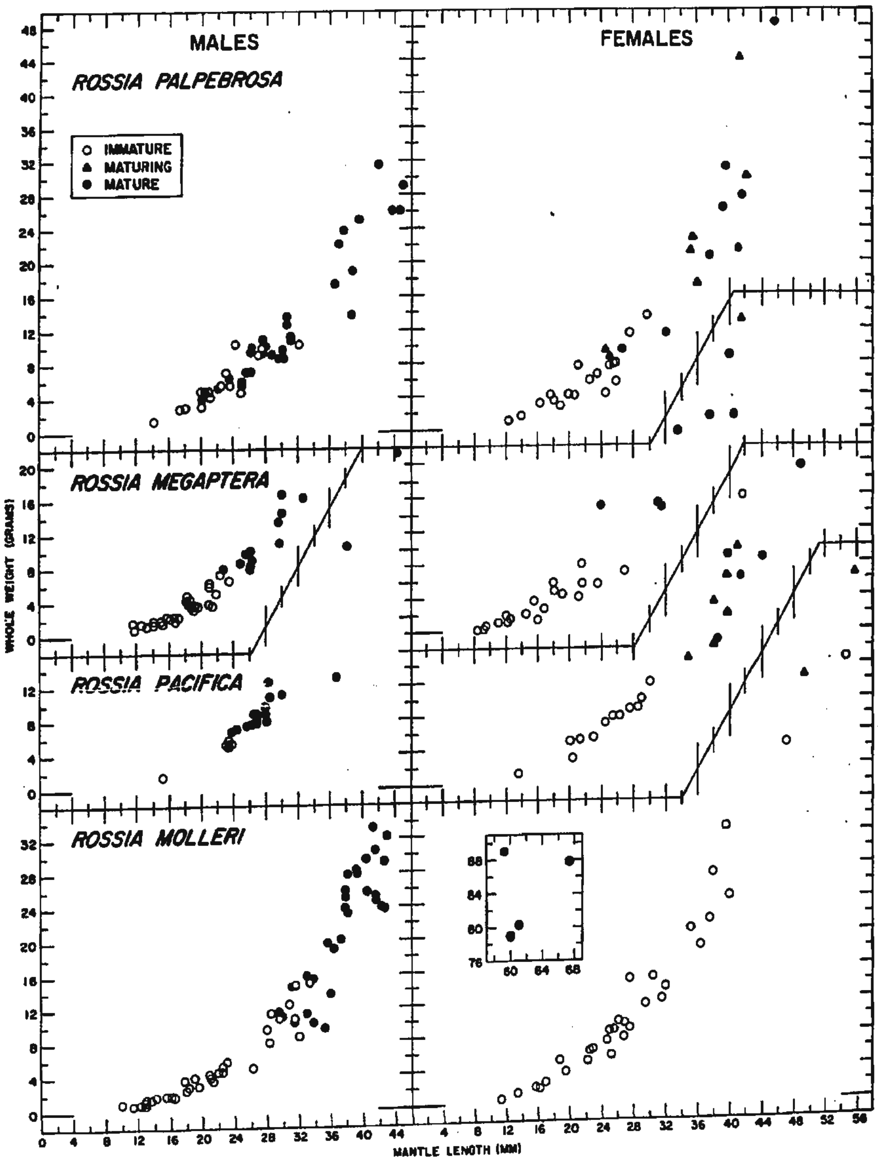

Fig. 15. Length - weight relationship for R. palpebrosa, R. megaptera,

R. pacifica and R. molleri.

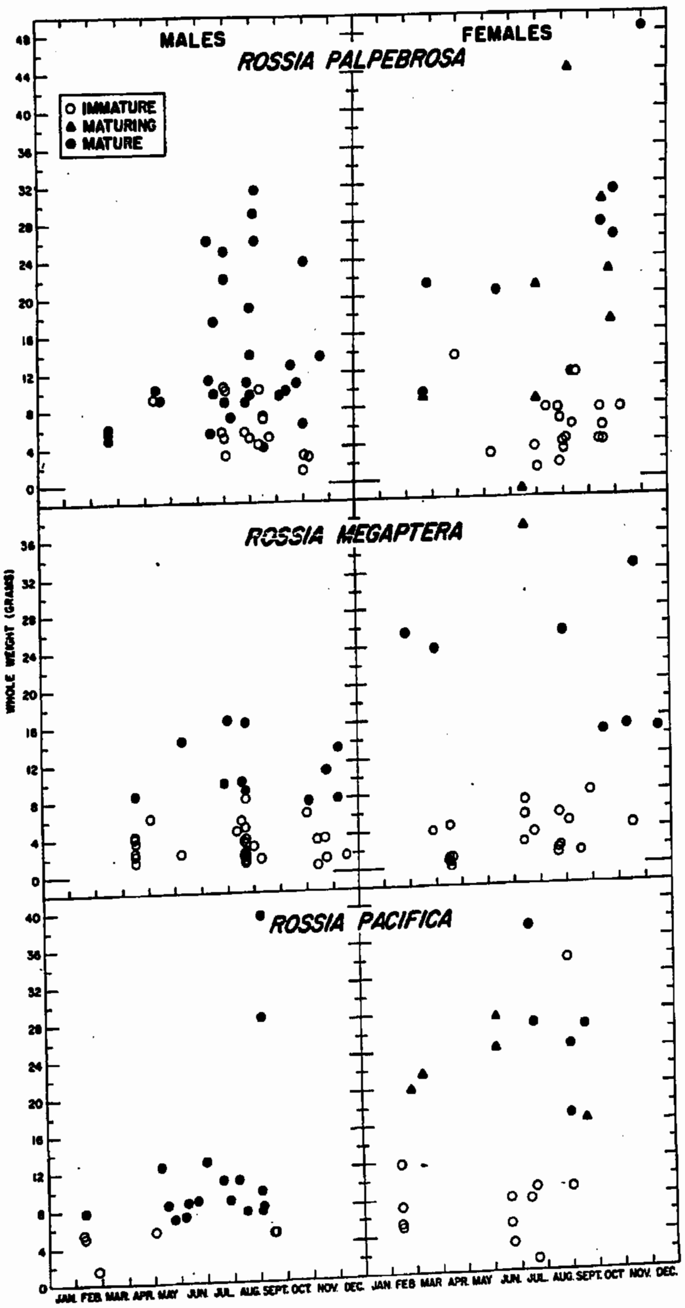

Fig. 16. Relationship of size and maturity to season for R. palpebrosa, R. megaptera and R. pacifica.

Mating

Spermatophores were found attached behind the eye and on the anterior margin of the mantle in specimens of *R. megaptera* and *R. palpebrosa*. In addition they were found attached on the postero-ventral mantle wall near the fin of a mature male *R. palpebrosa* (Fig. 17). Joubin (1920) illustrated spermatophores attached behind the eye in *R. palpebrosa* (= *R. glaucopis*) and Adam (1960) reported similar attachment in *R. caroli*. I also noted spermatophores attached on the ventral side of the head and funnel in *R. bullisi*.

Spawning

Rossia eggs were found in the cavities of sponge in four sets made on the NE Newfoundland Shelf in May-June, 1963, in depths 179 (-187) - 320 (-327) metres, bottom temperatures -0.24 to 2.2°C (see Appendix I, Table I). These were in small clusters, in various stages of development, some recently spawned, others already hatched. The eggs were encased in a round chitinous capsule about 9 mm diameter. Larvae in an advanced stage of development, nearly ready for hatching, were extracted from a few eggs; these had a dorsal mantle length of 6 mm. A single recently hatched specimen of 8 mm mantle length was positively identified as *R. palpebrosa* (primarily on the basis of the funnel organ configuration).

Verrill (1882) reported that *R. palpebrosa* (= *R. hyatti*) lays its eggs in August and September in various species of sponges. Both Sars (1878)

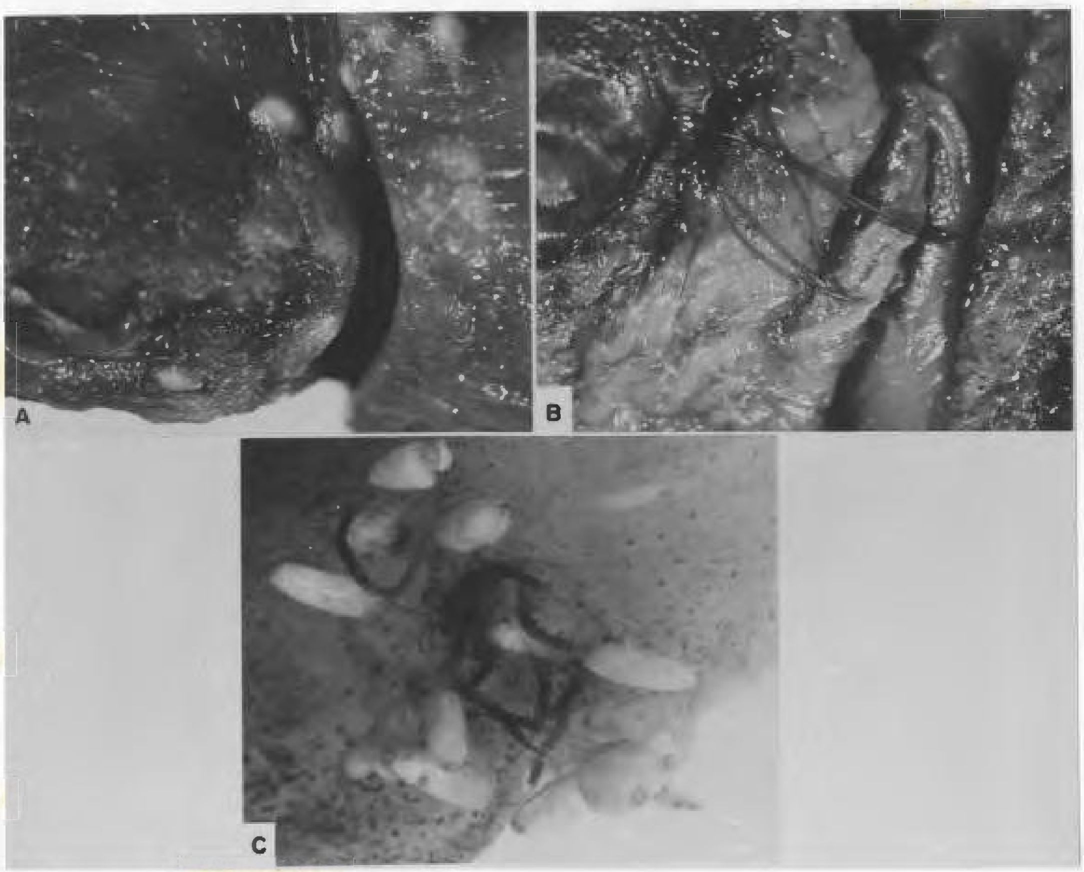

Fig. 17. Spermatophores attached: A. behind the eye and on the antero-dorsal margin of F _R_. _megaptera_ (Specimen R-35), B. behind the eye of F _R_. _megaptera_ (Specimen R-27), C. on the mantle near the fin of M _R_. _palpebrosa_ (Specimen R-180).

and Steenstrup (1900) have described and illustrated the eggs and recently hatched juveniles.

Eggs of R. molleri were collected on three occasions in August, in 14.6 (27) - 51 m[3], bottom temperatures -1.31 to 5.67°C (extrapolated). The substrate to which the masses were attached is not known. Diameters were 11-12 mm, considerably larger than those of R. palpebrosa (Fig. 18).

Food

Stomach contents of 74 specimens were examined (Table III). Of 15 R. palpebrosa stomachs with identified contents, occurrences of crustacea outnumbered those of fish by 10 to 5, only one stomach containing both. The ratio was 7:2 for R. megaptera with no mixture. In R. molleri fish occurred in 7 of 11 stomachs, crustacea in 2 and echinoderm and anemone remains in the other 2. Only 5 R. pacifica stomachs were examined, fish occurring in 2 and crustacea in 1.

Parasites

Specimens from which stomachs were removed were also examined for parasites on or in the stomach and caecum. In Rossia megaptera four specimens of a trematode,
were found in the caecum of Specimen R-64 and one was found in the stomach of Specimen R-67 (both squid are from the same collection in Hermitage Bay). Two small trematodes were found in the stomach of R. molleri, Specimen RM-94. No parasites were found in the other two species.

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[3]Two collections.

Fig. 18. Part of an egg mass of Rossia molleri, Specimen RM-110.

Table III. Stomach contents of *R. palpebrosa*, *R. megaptera*, *R. molleri* and *R. pacifica*. Parts from which identifications were made are indicated in brackets.

Species and Specimen No.	Sex, DML (mm) and whole weight (g, in brackets)	Stomach contents
R. palpebrosa		
R-33, 126, 153	M 25.5 (7.2), M 39.5 (25.1), F 29.6 (13.5)	empty
R-20, 96, 125	M 20.5 (4.9), F 41.3 (44.1), F 18.0 (3.5)	unidentified amorphous digested material
R-23	M 31.0 (11.3)	gammarid amphipod (pleura and legs)
R-88a	M 20.0 (3.1)	*Idothea* sp.
R-103	F 20.5 (4.0)	mysid (tail section)
R-117	F 35.0 (21.1)	? *Lithodes* sp. (legs, coxa, claws)
R-111	F 23.4 (6.5)	*Pandalus* sp. (telson, molar processes)
R-158	F 41.5 (27.7)	*Pandalus* sp. and fish (mandibles and bones)
R-130, 132	M 23.5 (5.6), F 25.0 (8.6)	crustacea (chitin)
R-108	M 27.0 (9.3)	crustacea and fish (chitin and bones)
R-14	M 44.5 (26.2)	shrimp (claw)
R-12	M 36.5 (17.6)	decapod crustacea (telson)
R-34, 112, 113, 159	M 20.0 (4.0), F 37.4 (20.5), M 38.7 (19.1), F 25.8 (5.6)	fish (fin rays, scale, scale and melanophores)

Cont'd.

Table III. Cont'd.

Species and Specimen No.	Sex, DML (mm) and whole weight (g, in brackets)	Stomach contents
R. megaptera		
R-39, 44, 58, 60, 62, 67	F 21.0 (4.0), F 23.5 (5.6), M 29.5 (13.5), M 29.7 (11.0), M 26.3 (9.0), M 18.8 (3.4)	empty
R-8, 9, 16, 29, 40, 43, 61, 63	F 40.0 (32.6), F 19.0 (4.4), M 25.5 (9.8), F 33.5 (23.7), M 30.0 (14.5), M 24.8 (8.6) F 23.9 (14.9), M 26.0 (8.2)	unidentified amorphous digested material
R-10, 27, 49, 65	F 37.5 (25.4), F 31.5 (14.6), M 15.8 (2.3), M 18.5 (3.9)	Pandalus sp. (mandibles)
R-66, 95, 128	M 21.4 (3.5), M 22.7 (7.9), M 30.0 (16.7)	shrimp (mandibles, uropods)
R-25, 32	F 40.5 (25.5), F 21.5 (8.0)	fish (scale and melanophores)
R. molleri		
RM-70, 81, 94, 99, 103, 106	M 29.5 (10.8), M 33.8 (15.5), M 40.4 (29.6), M 37.9 (25.8), M 33.0 (15.8)	empty
RM-68, 74, 77, 78, 80, 96, 97, 98	M 33.4 (15.0), F 35.2 (20.5), M 37.8 (23.8), M 41.5 (30.6), F 67.4 (87.7), M 37.9 (25.1), M 42.6 (29.3)	unidentified amorphous digested material
RM-71, 75, 79, 92, 95, 101, 102	F 29.5 (11.7), M 43.0 (32.3), M 36.4 (19.0), M 39.3 (28.0), F 54.5 (52.6), F 39.5 (32.6), M 41.3 (33.3)	fish (melanophores, vertebrae, fin rays, bones, tail section, etc.)

Cont'd.

Table III. Cont'd.

Species and Specimen No.	Sex, DML (mm) and whole weight (g, in brackets)	Stomach contents
RM-73	M 39.2 (28.2)	anemone
RM-76	M 41.5 (25.2)	echinoderm (pedicellaria)
RM-93	F 60.1 (79.0)	gammarid amphipod (urosome)
RM-100	F 47.1 (42.5)	shrimp (legs)
R. pacifica		
RP-7, 8	F 41.0 (27.9), F 39.6 (24.5)	empty
RP-15	F 49.1 (37.4)	crustacea (chitin)
RP-33, 6	F 34.8 (14.7), M 23.5 (5.1)	fish (bones and fin rays)

Summary

1. Collections examined comprised about 325 sepiolid squid specimens of the genus Rossia Owen, 1835 from the Canadian Atlantic, Arctic and Pacific.

2. The arctic-boreal *R. palpebrosa*, the genotype, is redescribed from nearly topotypic material and *R. glaucopis*, *R. sublevis*, *R. hyatti*, and *R. papillifera* are regarded as synonyms. The species is amphi-Atlantic, ranging southwards to ca. 32°N in the western Atlantic and 51°N on the eastern side. Depths of collections range from 104-549 metres, bottom temperatures -1.36 to 4.89°C.

3. The western Atlantic-boreal *R. megaptera* is redescribed from topotypic material and shown to be a valid species. As presently known it ranges from Hudson Canyon to Davis Strait in depths 179-1536 metres, bottom temperatures 1.67 to 5.38°C.

4. *R. tenera* is shown to be a tropical-boreal species, previous records from the Arctic being based upon misidentified specimens of *R. molleri* and the Canadian Atlantic record on a misidentified *R. megaptera*. It reaches the northern limit of its distribution on Georges Bank.

5. The eastern Atlantic species *R. caroli* is excluded from the western Atlantic fauna, records probably being based upon misidentified *R. megaptera*.

6. *R. molleri* is shown to be an arctic endemic, the only such known cephalopod. An apparently relict population was found in Hebron Fiord, Labrador. Depths for specimens reported here are 17-250 (-270) metres, bottom temperatures -1.37 to 5.83°C; nearly all collections were from water of negative temperatures. It appears not to be circum-arctic.

7. The amphi-Pacific *R. pacifica* is the only *Rossia* species occurring in the Canadian Pacific. It is arctic-boreal, ranging southwards to Sagami Bay, Japan and San Diego, California. It does not penetrate the Chukchi Sea. Reported depths range from 17 (-44) to 366 (-547) metres; no temperature data are available.

8. The gross morphology is considered from a taxonomic aspect. Individual variability was found to be so great that allomorphosis could be neglected for a consideration of morphometric characters in the taxonomy of the genus. Except for sucker size in some instances, indices of body proportions are of little taxonomic value. The most stable of the characters investigated are the structure of the club, funnel organ, anal papillae and palps and, particularly, the sexual characters of spermatophore and hectocotylus structure.

9. The subgenus (genus - some authors) *Allorossia*, founded upon material (*R. glaucopis*) synonymous with the genotype, is placed in synonymy with *Rossia*. The subgenus *Rossia* is here considered to comprise half of the known species: *R. palpebrosa* Owen (type, by monotypy), *R. megaptera* Verrill, *R. caroli* Joubin, *R. macrosoma* (Delle Chiaje), *R. bullisi* Voss, *R. tortugaensis* Voss, *R. mollicella* Sasaki, *R. brachyura* Verrill, *R. pacifica* Berry, *R. molleri* Steenstrup. In

these species both dorsal arms of the males are hectocotylized with expanded ventral bordering membranes. (There is also a secondary membrane or fold developed in _R. pacifica_ and _R. molleri_.) Club suckers are in approximately 5-16 transverse rows.

10. The subgenus _Austrorossia_ is here considered to include _R. australis_ Berry (type by original designation), _R. mastigophora_ Chun, _R. enigmatica_ Robson, _R. bipapillata_ Sasaki, _R. antillensis_ Voss. Both dorsal arms of the males are hectocotylized by the presence of a ventral fleshy pad and several enlarged pairs of suckers. Club suckers are in about 24-40 rows. Papillary organs are reported in most of these species; however these are also reported here for males only of _R. megaptera_, _R. bullisi_, and _R. caroli_ (the last of which the author has examined male specimens only).

11. Species included in the subgenus _Semirossia_ are _R. patagonica_ Smith, _R. equalis_ Voss, _R._ (_Semirossia_) sp. Voss, 1955. In this group the left dorsal arm only of males is hectocotylized. The club suckers are in 6-8 rows.

12. Of the 18 currently recognized species, 13 are found in the Atlantic; the only amphi-Atlantic species is the arctic-boreal _R. palpebrosa_, while the boreal and tropical species are endemic to one side. In the Pacific _Rossia_ is largely replaced by _Euprymna_. The fauna includes only six reported _Rossia_ species, the one _Semirossia_ being the only species common to both oceans. The arctic _R. molleri_ seems most closely related to the Pacific _R. pacifica_, suggesting possible

origin by isolation and resultant differential selection during Tertiary elevations of the Bering Strait. No *Rossia* species are reported from oceanic islands. Since the eggs are demersal and the newly hatched young non-planktonic, dispersal is limited by the locomotive powers of the juvenile and adult and hence fairly effectively restricted to areas where breeding is possible; this is strikingly reflected in the distribution patterns.

13. Females were classified as immature, maturing or mature dependent upon whether the most advanced ova were opaque, clearing, or clear, respectively. Members of the genus are polytelic with ova ripening in small clusters, each individual apparently spawning several times. Ova counts ranged from 125 to 545. Larger females lay slightly larger eggs. Ripe ovarian eggs are largest in the arctic *R. molleri* followed by *R. palpebrosa*; those of the other two species are slightly smaller.

14. Males were classified as immature or mature based upon the presence of spermatophores in the spermatophoric sac. The testis is small; maturation does not result in any enlargement and there is evidence of regression in size after spermatophore formation.

15. Males generally mature at smaller sizes and do not grow as large as the females; this is most pronounced in the arctic *R. molleri* which is the largest and latest maturing species studied, followed by the arctic-boreal species, with the boreal *R. megaptera* the smallest.

16. Gear selectivity and an apparently protracted spawning season precluded the obtaining of good growth data. No well-defined size

groups could be discerned in a plot of size and maturity against season.

17. Spermatophores in mated females were found attached behind the eye, on the anterior mantle margin and on the ventral side of the head and funnel.

18. Egg masses of *R. palpebrosa* and *R. molleri* were collected; the eggs were encased individually in chitinous capsules 9 mm and 11-12 mm in diameter, respectively. Those of *R. palpebrosa* were found in the cavities of sponge but the substrate of the *R. molleri* egg masses is not known.

19. Stomach contents were predominantly crustaceans and fish although remains of echinoderms and anemones were also found.

20. Trematodes were found in the stomach or caecum of two specimens of *R. megaptera* and one *R. molleri*. No parasites were found in specimens of the other two species.

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References

Adam, W. 1960. Les Céphalopodes de l'Institut Français de l'Afrique Noire. Bull. Inst. Français Afrique Noire, 22(2): 465-511.

Akimushkin, I. I. 1963. Golovonogie mollyuski morei SSSR Izdatel'stvo Akademii Nauk SSSR. Moskva 1963. (Cephalopods of the Seas of the U.S.S.R. Israel Program for Scientific Translations. 223 p. Jerusalem. 1965).

Anonymous. 1964. International code of zoological nomenclature adopted by the XV International Congress of Zoology, London, July, 1958. Int. Comm. for Zool. Nomenclature.

Berry, S. S. 1911. Preliminary notices of some new Pacific cephalopods. Proc. U.S. Nat. Mus., 60: 589-592.

1912. A review of the cephalopods of western North America. U.S. Fish. Doc. No. 761, p. 269-336, 18 figs., 25 pls. (reprinted from Bull. U.S. Bur. Fish., Vol. 30, 1910).

1914. The Cephalopoda of the Hawaiian Islands. U.S. Fish. Doc. No. 789, p. 257-362, 40 text figs., 11 pls. (reprinted from Bull. U.S. Bur. Fish., Vol. 32, 1912).

1918. Report on the cephalopods obtained by the F.I.S. Endeavour in the Great Australian Bight and other southern Australian localities. Biological Results of the Fishing Experiments carried on by the F.I.S. Endeavour, 1909-14, 4(5): 203-298, 67 figs., 30 pls.

Bruun, A. Fr. 1945. Cephalopoda. Zoology of Iceland, 4(64): 1-15.

Chun, C. 1913. Cephalopoda. Repts. Michael Sars N. Atlantic Deep-sea Exped., 1910, 3(1): 1-21.

Dawson, W. 1893. The Canadian Ice Age. Montreal.

Dunbar, M. J. 1951. Eastern Arctic waters. Bull. Fish. Res. Bd. Canada, 88: 131 p.

1958. Physical oceanographic results of the "Calanus" expeditions in Ungava Bay, Frobisher Bay, Cumberland Sound, Hudson Strait, and Northern Hudson Bay, 1949-1955. J. Fish. Res. Bd. Canada, 15(2): 155-201.

Dunbar, M. J. and E. H. Grainger. 1952. Station list of the "Calanus" expeditions, 1947-50. J. Fish. Res. Bd. Canada, 9(2): 65-82.

Dunbar, M. J. and H. H. Hildebrand. 1952. Contribution to the study of the fishes of Ungava Bay. J. Fish. Res. Bd. Canada, 9(2): 83-128.

Ekman, S. 1953. Zoogeography of the sea. Sidgwick and Jackson Ltd., London. 417 p.

Grainger, E. H. 1954. Station list of the Calanus expeditions, 1951-52, together with Frobisher Bay stations, 1948, 1950 and 1951, and Resolution Island stations, 1950. J. Fish. Res. Bd. Canada, 11(1): 98-105.

Grainger, E. H. and M. J. Dunbar. 1956. Station list of the "Calanus" expeditions, 1953-4. J. Fish. Res. Bd. Canada, 13(1): 41-45.

Grainger, E. H. and J. G. Hunter. 1959. Station list of the 1955-58 field investigations of the Arctic Unit of the Fisheries Research Board of Canada. J. Fish. Res. Bd. Canada, 16(4): 403-420.

Grimpe, G. 1922. Systematische übersicht der europäischen Cephalopoden. Sitzb. Naturf. Ges. Leipzig, Vols. 45-48, p. 36-52.

1933. Die Cephalopoden des arktischen Gebietes. Fauna Arctica, 6: 489-514.

Hachey, H. B. 1961. Oceanography and Canadian Atlantic waters. Bull. Fish. Res. Bd. Canada, 134: 120 p.

Hoyle, W. E. 1886. Report on the Cephalopoda collected by the H.M.S. Challenger during the years 1873-76. Rep. Sci. Res. Voy. H.M.S. Challenger, 1873-76, 16(44): 1-246, 33 pls.

1904. A diagnostic key to the genera of recent dibranchiate Cephalopoda. Mem. Proc. Manchester Literary and Philosophical Soc., 48(21): 1-20.

Jaeckel, S.G.A. 1958. Cephalopoden. Tierw. Nord-und Ostsee, Lief 37, Teil 963: 479-723.

Jatta, G. 1896. I Cefalopodi vivanti nel golfo di Napoli. Fauna u. Flora, Monogr. 23.

Jeffreys, J. G. 1869. British Conchology. London, V.

Johnson, C. W. 1934. List of Marine Mollusca of the Atlantic coast from Labrador to Texas. Proc. Boston Soc. Nat. Hist., 40(1): 1-204.

Joubin, L. 1902. Revision des Sepiolidae. Mem. Soc. Zool. France, 15(1): 80-145.

1920. Céphalopodes provenant des campagnes de la Princesse-Alice (1898-1910). Rés. Camp. Sci. Monaco, 3rd. ser., LIV: 1-95, 16 pls.

1924. Contribution à l'étude des céphalopodes de l'atlantique nord. Rés. Camp. Sci. Monaco, 67: 1-113.

Kondakov, N. N. 1941. Golovonogie mollyuski dal'nevostochnykh morei SSSR. Issledovaniya Dal'nevostochnykh morei SSSR. Vol. 1. (Cited from Akimushkin, 1963.)

1948. Klass Cephalopoda. Golovonogie mollyuski. In: Opredelitel' fauny i flory Severnykh morei SSSR. Sovetskaya Nauka. (Cited from Akimushkin, 1963.)

Lönnberg, E. 1899. (Cited from Grimpe, 1933 - no reference given.)

Lovén, S. 1845. Om nordiska Cephalopoder. Öfv. Svenska Akad. Forh. IV, 120-123.

MacGinitie, G. E. 1955. Distribution and ecology of marine invertebrates of Point Barrow, Alaska. Smithsonian Misc. Coll., 128(9): 201 p.

Mangold-Wirz, Katharina. 1963a. Contribution à l'étude de Rossia caroli Joubin. Vie et Milieu, 14(2): 205-224.

1963b. Biologie des céphalopodes benthiques et nectoniques de la Mer Catalane. Vie et Milieu, Suppl. 13: 285 p.

Muus, B. J. 1962. Cephalopoda. The Godthaab Expedition 1928. Medd. om Grønland, 81(5): 1-23.

1963. Cephalopoda, Sub-Order: Sepioidea. Cons. Perm. Explor. - Fisches d'Identif. du Zooplancton, 94: 1-5.

Norman, A. M. 1890. Revision of British Mollusca. Ann. Mag. Nat. Hist. 6th series, 5(59): 452-484.

Nutt, D. C. and L. K. Coachman. 1956. The oceanography of Hebron Fjord, Labrador. J. Fish. Res. Bd. Canada, 13(5): 709-758.

Odhner, N. H. 1923. Furth. Zool. Res. Swed. Antarct. Exped. 1901/03. Vol. 1. Stockholm. (Cited from Grimpe, 1933.)

Okutani, T. 1967. Preliminary catalogue of decapodan Mollusca from Japanese waters. Bull. Tokai Reg. Fish. Res. Lab., 50: 1-16.

Owen, R. 1835. Mollusca - Cephalopoda. I. Ross appendix to the narrative of a second voyage in search of a North West passage, 1829-1833. XCII-XCIX, pl. B, C.

Pfeffer, G. 1908. Die Cephalopoden. Nordisches Plankton, Zool. Teil, 2(4): 9-116.

Posselt, H. J. 1898. Grønlands Brachiopoder og Bløddyr. Ad. S. Jensen Publ. in Medd. om Grønland, 23: 1-298.

Sars, O. 1878. Bidrag til kundshaben om Norges Arkiske fauna. 1. Mollusca Regionis Arcticae Norvegiae. 338 p.

Sasaki, M. 1913. Decapod cephalopods found in Japan: Sepiolidae. Zool. Mag. Tokyo, 25: 247-252, 397-403, 4 figs., 1 pl. (in Japanese).

1921. Report on the cephalopods collected during 1906 by the United States Bureau of Fisheries steamer Albatross in the northwestern Pacific. Proc. U.S. Nat. Mus., 57: 163-203, 4 pls.

1929. A monograph of the dibranchiate cephalopods of the Japanese and adjacent waters. Jour. College Agric. Hokkaido Univ., Vol. 20, suppl., 357 p., 158 figs., 30 pls.

Squires, H. J. 1957. Decapod Crustacea of the Calanus expeditions in Ungava Bay, 1947 to 1950. Can. J. Zool., 35: 463-494.

Steenstrup, J. 1856. Hectocotylus formation in Argonauta and Tremoctopus explained by observations on similar formations in the Cephalopoda in general. Ann. Mag. Nat. Hist. Ser. 2, 20: 81-114. (Cited from English translation, published 1857).

1887. Notae Teuthologicae, 7. Overs. danske Vidensk. Selsk. Forh.: 67-126. (The Cephalopod papers of Japetus Steenstrup. English transl. by Volsøe, Knudsen, and Rees. Danish Science Press Ltd., Copenhagen, 1962.)

1900. *Heteroteuthis* Gray, med bemaerkninger om *Rossia* - *Sepiola* - Familien i Almindelighed. K. danske Vidensk. Selsk. Skrifter, 6. Raekke, bd. 9: 283-300. (p. 309 in above translations).

Tryon, G. W. 1879. Manual of conchology. 1: 1-316, 112 pls.

Uda, M. 1963. Oceanography of the subarctic Pacific Ocean. J. Fish. Res. Bd. Canada, 20(1): 119-179.

Verrill, A. E. 1878. Amer. J. Sci., 16: 208. (Cited from Verrill, 1881.)

1880. Synopsis of the Cephalopoda of the Northeastern Coast of America. Amer. J. Sci. XX.

1881. The cephalopods of the northeastern coast of America. Part II. The smaller cephalopods, including the "squids" and the octopus, with other allied forms. Trans. Conn. Acad. Arts Sci., 5: 259-446.

1882. Report on the cephalopods of the northeastern coast of America. Rep. U.S. Comm. Fish., 1879: 1-240.

Voss, G. L. 1950. Two new species of cephalopods from the Florida Keys. Rev. Soc. malac. de la Torre, 7(2): 73-79.

1954. Decapodous cephalopod molluscs from the Marshall Islands. Pacific Science, 8(3): 363-366.

1955. The Cephalopoda obtained by the Harvard-Havana expedition off the coast of Cuba in 1938-39. Bull. Mar. Sci. Gulf Caribb., 5(2): 81-115.

1956. A review of the cephalopods of the Gulf of Mexico. Bull. Mar. Sci. Gulf Caribb., 6(2): 85-178.

1960. Bermudan cephalopods. Fieldiana. Zoology, 39(40): 419-446.

1962. South African cephalopods. Trans. Roy. Soc. S. Afr., 36(4): 245-272.

1963. Cephalopods of the Philippine Islands. Bull. U.S. Nat. Mus., 234: 1-180.

Additional references

Hoyle, W. E. 1910. A list of the generic names of dibranchiate Cephalopoda with their type species. Senckenbergiana, 32: 407-13.

Thore, S. 1959. Reports on the Lund University Chile Expedition 1948-49. 33. Cephalopoda. Acta Univ. Lund. Ser. 2, 55: 1-19.

Appendix I

Table I. Specimens of Rossia palpebrosa examined by the author.

Sex and mantle length (mm)	Position N. lat.	Position W. long.	Depth (metres)	Bottom Temp.(°C)	Date Da.	Date Mo.	Date Yr.	Author's Register	Museum Register
1F: 27.5 1M: 23.0	53-29-00	54-45-30	229-238	0.9	15	9	63	R-1-2	-
1M: 30.5	48-39-20	63-18-00	181-187	3.04	20	11	61	R-3	-
1M: 45.0 1F: 24.5	60-27-30	66-20-00	183-187	-0.60	5	9	59	R-4-5	-
2M: 26.0, 20.0	62-59-00	63-00-00	196-205	-1.36	31	8	59	R-6-7	-
1M: 27.5	50-26-00	52-05-30	229-235	0.99	27	8	60	R-11	-
2M: 36.5, 30.0	46-13-00	47-42-00	183	-0.39	19	7	59	R-12-13	-
1M: 44.5	51-26-30	54-45-20	177-190	-0.22	12	8	62	R-14	-
1F: 21.0	53-27-00	54-36-00	155-187	1.10	7	11	64	R-15	-
1M: 27.5	53-00-00	52-28-00	256	2.61	4	10	58	R-17	-
1F: 45.5	47-12-30	55-48-00	183-187	0.97	30	11	52	R-19	-
1M: 20.5	47-27-00	44-42-30	229-240	3.74	20	3	61	R-20	-
1F: 32.0	47-54-00	44-44-00	311-320	3.82	11	9	64	R-21	-

Cont'd.

Table I. Cont'd.

Sex and mantle length (mm)	Position N. lat.	Position W. long.	Depth (metres)	Bottom Temp.(°C)	Date Da.	Date Mo.	Date Yr.	Author's Register	Museum Register
1M: 42.0	60-33-00	66-19-00	271-284	0.19	5	9	59	R-22	-
1M: 31.0	46-36-00	47-24-00	220-223	0.89	14	7	51	R-23	-
1M: 30.5	48-42-00	63-14-00	220	4.00	18	10	59	R-26	-
2M: 25.5, 20.0	53-31-00	54-42-30	174-183	0.85	15	9	63	R-33-34	-
1M: 29.5 1F: 25.0	50-35-00	52-52-30	302-320	2.88	25	8	60	R-36-37	-
1F: 41.0	47-07-00	47-05-00	247-262	3.53	26	3	61	R-38	-
1M: 38.6	62-58-30	62-13-30	274-293	1.13	31	8	59	R-81	-
1M: 26.0	54-43-00	53-55-00	271-276	3.67	7	8	60	R-82	-
1M: 22.3	50-35-30	52-55-45	360-380	2.48	25	8	60	R-83	-
1F: 13.9	50-21-30	51-20-00	289-298	3.29	27	8	60	R-84	-
3M: 30.1, 27.4, 20.0	55-38-00	58-25-00	311-329	2.2	2	8	60	R-86a,b,c.	-
1M: 24.8 1F: 12.3	57-00-00	59-38-00	274	0.44	1	8	60	R-88a,b.	-
1M: 17.2	53-26-30	54-37-30	216-229	1.10	7	11	64	R-89	-

Cont'd.

Table I. Cont'd.

Sex and mantle length (mm)	Position N. lat.	Position W. long.	Depth (metres)	Bottom Temp.(°C)	Date Da.	Date Mo.	Date Yr.	Author's Register	Museum Register
1M: 22.1	47-07-00	44-52-00	165-190	3.12	16	7	50	R-90	-
1F: 16.2	63-01-00	62-34-30	229	-0.25	31	8	59	R-91	-
1M: 23.5	46-36-00	59-27-00	201	NA	1	11	62	R-92	-
1M: 43.6 1F: 41.3	60-26-00	67-00-00	104-106	0.56	5	9	59	R-96-97	-
1F: ca. 35-40	60-52-00	67-00-00	540-549	1.46	6	9	59	R-98	-
1F: 18.8	54-30-00	53-38-00	276	2.15	8	6	58	R-99	-
2M: 24.1, 21.0 1F: 22.4	55-02-00	55-25-00	256-258	1.11	10	9	53	R-100-102	-
1F: 20.5	50-22-00	52-30-00	296-302	2.79	30	8	60	R-103	-
2F: 26.5, 24.5 1M: 25.0	47-23-00	44-44-00	181-183	3.40	20	3	61	R-104-106	-
1M: 25.0	47-06-00	44-54-00	146-150	3.00	20	3	61	R-107	-
1M: 27.0	43-20-30	51-32-15	115	3.08	12	5	66	R-108	-
1M: 18.0	47-06-30	60-08-00	205-209	4.74	2	11	52	R-109	-
1M: 20.5	52-03-00	51-12-00	311-326	2.91	22	9	50	R-110	-
1F: 23.4	50-22-00	51-46-00	274-278	2.7	27	8	60	R-111	-

Cont'd.

Table I. Cont'd.

Sex and mantle length (mm)	Position N. lat.	Position W. long.	Depth (metres)	Bottom Temp.(^{o}C)	Date Da.	Date Mo.	Date Yr.	Author's Register	Museum Register
1F: 37.4	NA	NA	159	-0.02	?	6	?	R-112	-
1M: 38.7	49-59-00	53-19-00	227-238	-0.5	30	8	60	R-113	-
1M: 14.1	46-34-00	59-24-00	249-256	4.87	1	11	52	R-114	-
2F: 39.4, 39.0	57-00-00	59-13-00	271-274	1.80	29	10	64	R-115-116	-
1F: 35.0	56-59-00	59-46-30	181-185	-0.67	1	8	60	R-117	-
1M: 36.3	55-28-00	56-35-00	318-329	1.04	4	8	60	R-118	-
2F: 25.5, 16.5	53-40-30	53-06-00	229	1.67	11	8	60	R-120-121	-
1M: 33.0	NA	NA	NA	NA		NA		R-122	-
1F: 18.0	70-03-00	56-44-00	177-183	2.42	28	7	65	R-125	-
1M: 39.5, 37.0	68-54-00	56-47-00	225-238	0.81	1	8	65	R-126-127	-
2M: 32.0, 23.5	70-07-00	55-39-00	91-101	-0.35	28	7	65	R-129-130	-
1F: 25.0	47-20-30	48-38-00	138-143	1.08	30	7	66	R-132	-
eggs 7 x 9 mm, no larvae developing	48-48-00	52-39-00	210-230	-0.24	1	6	63	R-134	-
eggs 9 x 9 mm, mostly hatched some with larvae ML 6 mm	51-26-20	54-42-45	179-187	-0.23	31	5	63	R-135	-

Cont'd.

Table I. Cont'd.

Sex and mantle length (mm)	Position N. lat.	Position W. long.	Depth (metres)	Bottom Temp.(°C)	Date Da.	Date Mo.	Date Yr.	Author's Register	Museum Register
eggs 9 x 9 mm, with larvae ML 6 mm	49-08-30 49-17-00	52-02-00 52-07-00	291, 320-327	2.0, 2.2	2	6	63	R-136	-
hatched eggs, 1 larva hatched ML 8 mm	51-25-00	54-21-00	220-240	0.53	31	5	63	R-137	-
1F: 25.1	51-24-00	50-22-00	318-324	3.29	29	5	63	R-138	NMC-38808
1F: 25.8 2 sex indet.: 7.8, 7.0 latter still with piece of egg shell	51-25-00	54-21-00	220-240	0.53	31	5	63	R-139 R-151-152	NMC-38804 NMC-38802
1F: ca. 18.1	51-25-30	51-16-30	265-280	2.55	30	5	63	R-140	NMC-38809
1M: 22.6 1F: 30.1	52-30-30	52-02-00	276-278	3.04	27	5	63	R-141-142	NMC-38806
1M: 24.1	51-25-30	50-26-00	274-278	3.29	29	5	63	R-143	NMC-38805
3F: 41.8, 39.3, 15.2	49-08-30	52-02-00	291	2.00	2	6	63	R-144-146	NMC-38811
2F: 34.8, other damaged, about same size	ca. 44	ca. 66	91	NA	24	9	65	R-147-148	NMC-38833

Cont'd.

Table I. Cont'd.

Sex and mantle length (mm)	Position N. lat.	Position W. long.	Depth (metres)	Bottom Temp. (°C)	Date Da.	Date Mo.	Date Yr.	Author's Register	Museum Register
1F: 46.2	ca. 46-38	ca. 61-01	from cod stomach	NA	22	6	17	R-149	NMC-38836
1F: 24.9	51-24-50	51-05-00	227-234	2.14	29	5	63	R-150	NMC-38807
1F: 29.6	46-35-30	57-24-00	141-146	2.20	27	4	67	R-153	-
1M: 26.2 1F: 17.5	60-13-00	62-53-00	174-192	1.60	11	10	66	R-154-155	-
1F: 25.5	58-01-00	61-28-00	137-155	0.20	13	10	66	R-156	-
4F: 42.1, 41.5, 25.8, 19.8	53-35-00	55-10-30	212-232	0.70	16	10	66	R-157-160	-
1M: 33.5	62-12-00	69-38-00	274	NA	3	8	66	R-170	B-12 Sta. 221
1F: dried up	ca. 80-00	ca. 86-00	270	NA	10	9	55	R-171	NMC-4528
1M: 27.8	47-45-30	60-38-00	183-190	3.16	14	5	67	R-172	-
1M: 28.6	49-33-00	59-56-00	139-146	-1.28	19	5	67	R-173	-
1F: 35.9	49-33-45	59-56-15	143-146	1.65	25	10	66	R-177	-
1F: 35.3	55-33-00	58-25-00	225-236	0.78	24	10	67	R-178	-
1M: 37.6	50-45-00	54-45-00	177-192	0.41	3	11	67	R-179	-
1M: 31.0	55-29-50	56-52-00	232-274	3.42	23	10	67	R-180	-

Table II. Specimens of *Rossia megaptera* examined by the author.

Sex and mantle length (mm)	Position N. lat.	Position W. long.	Depth (metres)	Bottom Temp.(°C)	Date Da.	Date Mo.	Date Yr.	Author's Register	Museum Register
1F: 40.0	48-48-00	61-58-00	329-335	4.88	18	11	61	R-8	-
1F: 19.0	48-46-00	63-04-00	351-366	4.84	14	11	60	R-9	-
1F: 37.5	50-26-30	50-47-30	322-333	3.7	27	8	60	R-10	-
1M: 25.5	50-04-00	58-32-30	NA	NA	26	7	57	R-16	-
1M: 21.0	48-40-45	63-16-00	252-265	4.36	20	11	61	R-18	-
1M: 19.0	63-04-00	61-20-00	366	2.15	31	8	59	R-24	-
1F: 40.5	47-24-00	56-09-00	183-190	NA	24	2	57	R-25	-
2F: 31.5, 33-38 (damaged)	48-42-00	63-14-00	219.5	4.00	18	10	59	R-27-28	-
1F: 33.5	48-04-00	48-09-00	499-525	3.71	29	3	61	R-29	-
2M: 26.0, 21.0	ca. 47-30	ca. 56-20	NA	NA	?	8	56	R-30-31	-
1F: 21.5	52-28-00	52-29-00	293	2.67	29	9	59	R-32	-
1F: 31.0	42-16-00	65-09-30	421-476	4.77 at 503 metres	9	11	59	R-35	-
1F: 21.0	47-07-00	47-05-00	247-262	3.53	26	3	61	R-39	-

Cont'd.

Table II. Cont'd.

Sex and mantle length (mm)	Position N. lat.	Position W. long.	Depth (metres)	Bottom Temp.(°C)	Date Da.	Date Mo.	Date Yr.	Author's Register	Museum Register
2M: 30.0, 15.7, 1 unsexed: ca. 20 damaged	47-33-00	56-08-45	245-252	4.97	12	6	55	R-40-42	-
7F: 23.5, 11.1, 9.4, 9.2, 8.4, 12.2, 12.5 7M: 24.8, 14.0, 18.2, 18.5, 19.6, 15.9, 15.8	ca. 47-30	ca. 56-20	220-293	NA	?	4	54	R-43-56	-
1M: 21.0	43-07-30	51-12-00	179-187	3.09	2	5	66	R-57	-
2M: 29.5, 26.0	47-34-30	55-58-00	249-262	4.93 extrapolated	6	12	55	R-58-59	-
1M: 29.7	47-33-30	56-05-00	NA	3.90 extrapolated	21	11	59	R-60	-
1F: 23.9	47-39-30	55-43-15	201-274	NA	16	12	53	R-61	-
13M: 33.0, 26.9, 19.0, 20.2, 25.3, 15.4, 18.7, 12.8, 15.5, 14.8, 15.5, 16.5, 16.0 3F: 20.0, 14.9, 15.3 1 sex indet.: 10-15 (damaged)	47-34-00	56-06-00	247-254	NA	21	8	55	R-62-78	-

Cont'd.

Table II. Cont'd.

Sex and mantle length (mm)	Position N. lat.	Position W. long.	Depth (metres)	Bottom Temp.(°C)	Date Da.	Date Mo.	Date Yr.	Author's Register	Museum Register
1M: 22.3	ca. 47-30	ca. 61-30	183	NA	NA			R-79	-
1M: 14.0	47-38-15	55-58-30	285-293	NA	17	12	53	R-80	-
1M: 21.8	51 ?	?	311-320	2.70	20	8	52	R-85	-
1M: 11.8	49-12-00	59-36-00	247-254	4.62	13	11	61	R-87	-
1M: 23.4	46-36-30	59-27-00	201	4.50	1	11	62	R-93	-
1F: 16.7	46-58-00	43-58-00	360-362	3.54	10	7	50	R-94	-
1M: 22.7	46-34-00	59-24-00	256	4.87	1	11	52	R-95	-
1M: 18.3	53-40-30	53-06-00	229	1.67	11	8	60	R-119	-
1F: 39.5	48-27-00	62-06-00	369	NA	11	10	60	R-123	NMC-23069
1M: 31.0	48-20-00	62-08-00	179-187	NA	11	10	60	R-124	NMC-23070
1M: 30.0	68-54-00	56-47-00	225-238	0.81	1	8	65	R-128	-
1M: ca. 12.5	49-08-30	59-26-30	209-220	3.53	22	11	65	R-133	-
1F: 41.5	48-57-00	45-00-00	1481-1536	3.44	13	7	65	R-131	-
1F: 18.0	ca. 49-10	ca. 64-10	201-205	4.0	2	9	54	R-161	D-21
1F: 15.5	ca. 49-10	ca. 64-10	238	4.6	22	7	54	R-162	D-8
1F: 12.5	ca. 49-10	ca. 64-10	220-225	4.5	14	9	54	R-163	D-48

Cont'd.

Table II. Cont'd.

Sex and mantle length (mm)	Position N. lat.	Position W. long.	Depth (metres)	Bottom Temp.(°C)	Date Da.	Date Mo.	Date Yr.	Author's Register	Museum Register
1M: 11.5	ca. 49-10	ca. 64-10	218-221	4.4	8	9	54	R-164	D-34
1 sex indet.: ca. 14.5	ca. 49-10	ca. 64-10	201	4.1	20	8	54	R-165	D-11
1 sex indet.: ca. 13	ca. 49-10	ca. 64-10	219	4.3	19	7	54	R-166	D-10
1M: 21.8	51-24-00	50-22-00	318-324	3.29	29	5	63	R-167	NMC-38808
1M: ca. 20	51-24-30	51-33-20	324-333	2.68	30	5	63	R-168	NMC-38810
1M: 13.5	59-59-00	61-00-00	274-282	3.91	12	10	66	R-169	-
1M: 19.2	48-47-00	59-40-00	218-220	4.66	12	11	57	R-174	-
1F: 26.9	46-41-00	47-19-00	293	2.28	13	7	54	R-175	-
1F: 21.6	44-25-00	53-28-00	227	4.49	11	7	65	R-176	-

Table III. Specimens of <u>Rossia</u> <u>molleri</u> examined by the author.

Sex and mantle length (mm)	Position N. lat.	Position W. long.	Depth (metres)	Bottom Temp.(°C)	Date Da.	Date Mo.	Date Yr.	Author's Register	Museum Register
1F: 30.4	70-16-00	125-42-30	174	-1.27 (Aug. 5, extra-polated)	25	8	63	RM-1	(63-031, I-168)
2M: 36.0, 31.2	70-03-54	125-28-30	90-92	-0.51	4	8	63	RM-2-3	(63-012, I-88)
1M: 42.3	ca. 80-00	ca. 86-00	51	NA	7	9	55	RM-4	(55-109)
1F: 27.5 2M: 22.5, 18.0	69-27-00	124-17-00	30	5.83	13	8	63	RM-5-7	(63-022, I-140)
6F: 55.9, 38.0, 32.0, 31.6, 25.5, 25.0 6M: 37.3, 35.6, 31.5, 31.4, 22.5, 21.0	70-14-18	124-34-24	0-65	-0.94	28	8	63	RM-8-14 RM-34-38	(63-032, I-175) (63-032, I-178)
1F: 37.5 2M: 41.6, 29.8	70-10-00	124-02-42	60-80	-0.52 (extra-polated)	7	8	63	RM-15-17	(63-016, I-112)
2F: 36.4, 26.2 1M: 32.0	69-49-42	123-05-30	82	2.19	12	8	63	RM-18-20	(63-019, I-127)
2F: 27.5, 26.8 3M: 19.5, 16.0, 10.0	69-39-18	123-33-18	46-52	4.44	12	8	63	RM-22-26	(63-020, I-133)

Cont'd.

Table III. Cont'd.

Sex and mantle length (mm)	Position N. lat.	Position W. long.	Depth (metres)	Bottom Temp.(°C)	Date Da.	Date Mo.	Date Yr.	Author's Register	Museum Register
1F: 40.0 2M: 30.8, 19.0 eggs: (no larvae developing)	70-02-06	125-22-18	40-50	-1.31	1	8	63	Squid: RM-27-29 Eggs: RM-52	(63-010, I-76) (63-010, I-75)
1M: 33.0	70-11-24	124-16-42	45-64	-0.52 (extra-polated)	7	8	63	RM-30	(63-015, I-109)
1M: 28.5	69-18-30	81-35-30	75	-0.56	25	9	55	RM-31	(718, B-17)
1F: 18.7 1M: 13.0	70-10-36	124-47-00	18-24	4.36 at 20m -0.22 at 30m	4	8	63	RM-32-33	(63-013, I-97)
2M: 28.0, 20.8	69-43-12	82-07-00	55	-0.17	18	8	56	RM-38A-39	(815, B-29)
1F: 24.7 1M: 22.0	70-13-30	124-39-36	65.8	-0.94 (extra-polated)	5	9	63	RM-40-41	(63-035, I-187)
2M: 29.5, 21.3	70-04-00	125-10-00	33	5.66 at 30m 1.10 at 50m	20	8	63	RM-42-43	(63-027, I-165)
1F: 25.4	69-52-00	125-54-00	110-130	-1.08 at 75m	20	8	63	RM-44	(63-025, I-151)

Cont'd.

Table III. Cont'd.

Sex and mantle length (mm)	Position N. lat.	Position W. long.	Depth (metres)	Bottom Temp. (^{o}C)	Date Da.	Date Mo.	Date Yr.	Author's Register	Museum Register
5M: 33.8, 31.4, 28.3, 23.0, 26.2 1 unsexed 35.2, eggs with advanced larvae	70-10-30	124-30-00	15 27	5.67 (extra-polated)	9	8	63	RM-45-49 RM-21	(63-018, I-119) (63-018, I-115)
1M: 22.3	69-52-12	125-49-00	54.8	1.10 at 50m -0.45 at 60m	20	8	63	RM-50	(63-026, I-155)
1M: 16.5	ca. 79-07	ca. 102-30	9	NA	5	8	54	RM-51	(NMC-35061)
2M: 14.2, 13.0	80-00-00	86-00-00	2-70	-1.34	22	7	62	RM-54-55	(NMC-36754)
1M: 40.5	80-00-00	86-00-00	2-70	-1.34	9	8	62	RM-53	(NMC-36754)
1M: 13.0 1F: 13.5	69-02-48	105-16-36	38	NA	6	9	64	RM-56-57	(NMC-36374)
1F: 19.5	69-10-06	105-50-00	50	-1.27	27	8	65	RM-58	(NMC-36372)
1M: 17.7	68-18-12	109-15-00	120	-1.37	23	8	65	RM-59	(NMC-36373)
1F: 17.0	ca. 80-00	ca. 86-00	250-270	NA	7	8	55	RM-60	(NMC-35062)
2M: 42.5, 29.0	ca. 57-55	ca. 62-50	91	NA	12	8	49	RM-61-62	(USNM-574529)
1 unsexed: ca. 10 dried up	78-55	102-30	20	NA	11	8	54	RM-63	(NMC-4506)

Cont'd.

Table III. Cont'd.

Sex and mantle length (mm)	Position N. lat.	Position W. long.	Depth (metres)	Bottom Temp.(°C)	Date Da.	Date Mo.	Date Yr.	Author's Register	Museum Register
4 unsexed: ca. 15, 9, 8, 7	78-55	102-30	17	NA	10	8	54	RM-64-67	(NMC-35060)
1M: 33.4 1F: 22.2	69-10-12	105-50-42	49-51	-1.19	14	8	66	RM-68-69	(66-1072)
1M: 29.5	69-10-12	105-50-42	49-51	-1.12	17	8	66	RM-70	(66-1091)
1M: 13.6 1F: 29.5	69-10-12	105-50-42	49-51	-1.5	20	8	67	RM-71-72	(67-1124)
1M: 39.2 1F: 35.2	69-10-12	105-50-42	49-51	-	16	8	66	RM-73-74	(66-1080)
2M: 43.0, 41.5	69-10-12	105-50-42	49-51	-1.21	18	8	67	RM-75-76	(67-1109)
1M: 37.8	69-10-12	105-50-42	49-51	-1.12	17	8	66	RM-77	(66-1095)
1M: 41.5	69-10-12	105-50-42	49-51	-0.98	23	8	66	RM-78	(66-1097)
1M: 36.4	69-10-12	105-50-42	49-51	-1.24	4	8	66	RM-79	(66-1025)
1F: 61.2	69-10-12	105-50-42	49-51	-1.24	4	8	66	RM-80	(66-1026)
1M: 33.8	69-10-12	105-50-42	49-51	-1.5	20	8	66	RM-81	(67-1128)
1M: 18.3	69-10-12	105-50-42	49-51	-1.13	7	8	66	RM-82	(66-1044)
1M: 12.4	69-10-12	105-50-42	49-51	-1.13	7	8	66	RM-83	(66-1046)

Cont'd.

Table III. Cont'd.

Sex and mantle length (mm)	Position N. lat.	Position W. long.	Depth (metres)	Bottom Temp.(°C)	Date Da.	Date Mo.	Date Yr.	Author's Register	Museum Register
1M: 11.4	69-10-12	105-50-42	49-51	-1.00	24	8	66	RM-84	(66-1098)
1F: 11.4	69-10-12	105-50-42	49-51	-	14	8	66	RM-85	(66-1070)
1M: 15.5	69-10-12	105-50-42	49-51	-1.21	19	8	67	RM-86	(67-1121)
1F: 63.9	69-10-12	105-50-42	49-51	-1.18	6	8	66	RM-87	(66-1037)
1F: 59.2	69-10-12	105-50-42	49-51	-1.13	7	8	66	RM-88	(66-1047)
1M: 38.2	69-10-12	105-50-42	49-51	-1.10	5	8	66	RM-89	(66-1030)
1M: 38.1	69-10-12	105-50-42	49-51	-1.24	4	8	66	RM-90	(66-1019)
1F: 49.3	69-10-12	105-50-42	49-51	-1.13	7	8	66	RM-91	(66-1045)
1M: 39.3	69-10-12	105-50-42	49-51	-1.30	3	8	66	RM-92	(66-1010)
1F: 60.1	69-10-12	105-50-42	49-51	-1.24	4	8	66	RM-93	(66-1024)
1M: 40.4	69-10-12	105-50-42	49-51	-0.98	23	8	66	RM-94	(66-1099)
1F: 54.5	69-10-12	105-50-42	49-51	-1.35	1	9	67	RM-95	(67-1139)
1F: 67.4	69-10-12	105-50-42	49-51	-1.24	25	8	66	RM-96	(66-1101)
1F: 37.9	69-10-12	105-50-42	49-51	-1.15	16	8	66	RM-97	(66-1088)
1M: 42.6	69-10-12	105-50-42	49-51	-1.19	14	8	66	RM-98	(66-1066)

Cont'd.

Table III. Cont'd.

Sex and mantle length (mm)	Position N. lat.	Position W. long.	Depth (metres)	Bottom Temp.(°C)	Date Da.	Date Mo.	Date Yr.	Author's Register	Museum Register
1M: 37.9	69-10-12	105-50-42	49-51	-1.15	12	8	66	RM-99	(66-1059)
1F: 47.1	69-10-12	105-50-42	49-51	-1.10	5	8	66	RM-100	(66-1031)
1F: 39.5	69-10-12	105-50-42	49-51	-1.18	6	8	66	RM-101	(66-1039)
1M: 41.3	69-10-12	105-50-42	49-51	-1.12	17	8	66	RM-102	(66-1092)
1M: 42.6	69-10-12	105-50-42	49-51	-1.15	16	8	66	RM-103	(66-1090)
2F: 22.6, 22.8	69-10-12	105-50-42	49-51	-1.12	17	8	66	RM-104-105	(66-1094)
1M: 33.0 3F: 26.9, 15.8, 16.2	69-10-12	105-50-42	49-51	-1.35	18	8	67	RM-106-109	(67-1110)
Eggs only	69-10-12	105-50-42	49-51	-1.18	6	8	66	RM-110	(67-1039)

Table IV. Specimens of Rossia pacifica examined by the author.

Sex and mantle length (mm)	Position N. lat.	Position W. long.	Depth (metres)	Bottom Temp.(°C)	Date Da.	Date Mo.	Date Yr.	Author's Register	Museum Register
1M: 38.2	57-31-07	151-21-00	110	NA	6	9	63	RP-1	(63-97)
1M: 32.7	57-07-05	127-28-00	29-31	NA	21	5	62	RP-2	-
1M: 44.4	57-19-08	151-24-00	110	NA	7	9	63	RP-3	(63-104)
1F: 41.7	58-02-00	151-37-00	110	NA	29	8	63	RP-4	(63-61)
1M: 36.9	49-59-06	124-58-12	113	NA	27	6	62	RP-5	-
1M: 23.5	54-22-30	130-35-00	NA	NA	12	2	60	RP-6	-
2F: 41.0, 39.6	NA	NA	NA	NA	5	6	34	RP-7-8	-
3F: 39.8, 28.6, 13.7 1M: 30.0	49-01-05	123-35-25	NA	NA	19	7	28	RP-9-12	-
2F: 25.5, 21.3	49-46-00	127-03-00	45-55	NA	20	6	34	RP-13-14	-
1F: 49.1	53-34-00	129-35-10	NA	NA	11	7	06	RP-15	-
4F: 30.1, 24.5, 23.0, 20.1 2M: 25.7, 23.5	54-22-30	130-35-00	NA	NA	12	2	60	RP-16-21	-
1M: 28.4	NA	NA	NA	NA	8	5	34	RP-22	-
1M: 24.4	49-13-30	126-43-00	113	NA	5	6	34	RP-23	-

Cont'd.

Table IV. Cont'd.

Sex and mantle length (mm)	Position N. lat.	Position W. long.	Depth (metres)	Bottom Temp.(°C)	Date Da.	Date Mo.	Date Yr.	Author's Register	Museum Register
1M: 27.0	NA	NA	NA	NA	15	5	34	RP-24	-
1F: 26.3	ca. 48-56-00	123-36-00	27-55	NA	11	7	19	RP-25	-
1M: 23.9	49-10-30	126-10-15	50	NA	23	5	34	RP-26	-
1M: 28.0	E of Blackwater Is.		NA	NA	26	7	13	RP-27	-
1M: 23.5	49-16-00	124-09-15	NA	NA	2	5	32	RP-28	-
1M: 27.1	49-12-10	123-54-25	18-55	NA	9	6	20	RP-29	-
1M: 26.6	49-06-10	123-45-00	55	NA	18	6	65	RP-30	-
1 sex indet.: 8.0	54-33-45	130-23-05	NA	NA	20	7	06	RP-31	-
1F: 20.4	49-16-00	124-09-15	46	NA	22	6	17	RP-32	-
1F: 34.8	NA	NA	NA	NA		NA		RP-33	-
1F: ca. 28-30	NA	NA	NA	NA		NA		RP-34	-
1M: 26.3	NA	NA	NA	NA	15	8	62	RP-35	-
1M: 15.3	51-06-05	128-31-00	146 (?)	NA	25	2	63	RP-36	(63-29)
1F: 39.7	51-10-05	128-33-05	183	NA	25	2	63	RP-37	(63-30)
1F: ca. 38	NA	NA	NA	NA	9	3	63	RP-38	-

Cont'd.

Table IV. Cont'd.

Sex and mantle length (mm)	Position N. lat.	W. long.	Depth (metres)	Bottom Temp.(°C)	Date Da.	Mo.	Yr.	Author's Register	Museum Register
1M: 28.1	54-41-00	133-32-00	NA	NA	3	9	66	RP-39	NMC-45599
1F: 41.4	ca. 54	ca. 132	NA	NA	30	8	66	RP-40	NMC-45596
2M: 23.8, 23.4 2F: 44.1, 38.0	51-55-12	128-24-50	128, 201	NA	14	9	66	RP-41-44	NMC-45598
2M: 28.0, 26.9	ca. 54-41	ca. 133-32	NA	NA	2	9	66	RP-45-46	NMC-45601
2M: 34.0, 33.8 4F: 57.7, 42.1, 36.9, 23.0	49-18-00	123-00-00	NA	NA	13	6	33	RP-47-52	NMC uncat.
2F: 38.5, 27.5	54-30-00	133-20-00	139	NA	31	8	66	RP-53-54	NMC-45597
1M: 28.5 3 unsexed: .6-.7	ca. 53-32	ca. 131-09	77	NA	6	8	65	RP-55-58	NMC-46083

Appendix II

Table I. Measurements and indices of specimens of Rossia palpebrosa treated in Fig. 9.

	M	M	M	M	M	M	M	M	M	M	M	M	M	M
	R-7	R-34	R-20	R-2	R-33	R-82	R-6	R-108	R-17	R-11	R-36	R-13	R-3	R-26
DML	20.0	20.0	20.5	23.0	25.5	26.0	26.0	27.0	27.5	27.5	29.5	30.0	30.5	30.5
VMLI	100.0	82.5	92.7	91.3	78.4	94.2	86.5	101.1	92.7	92.7	84.7	88.3	98.4	100.0
MWI	82.5	82.5	85.4	84.8	78.4	85.4	80.8	75.6	81.8	89.1	-	73.3	77.0	78.7
HLI	77.5	80.0	73.2	82.6	74.5	73.1	67.3	64.8	78.2	81.8	67.8	73.3	73.8	77.0
HWI	85.0	82.5	71.2	82.6	72.5	69.2	76.9	62.2	69.1	76.4	71.2	71.7	75.4	77.0
FLI	65.0	62.5	51.2	69.6	54.9	50.0	63.5	65.9	61.8	61.8	54.2	56.7	65.6	62.3
FII	55.0	45.0	43.9	52.2	45.1	43.5	57.7	54.8	49.1	52.7	47.5	45.0	50.8	52.5
FWI	157.5	145.0	136.6	165.2	143.1	146.5	138.5	131.1	130.9	141.8	127.1	116.7	147.5	124.6
FWIs	35.0	35.0	39.0	39.1	43.1	46.5	34.6	37.0	32.7	41.8	33.9	26.7	39.3	39.3
FPI	25.0	27.5	29.3	28.3	13.7	37.7	15.4	22.6	34.5	27.3	22.0	26.7	31.1	23.0
SIs	5.0	6.5	7.3	7.4	6.3	6.5	6.2	7.0	6.2	6.4	5.4	5.0	6.9	6.6
SIt	1.5	1.5	2.0	2.0	1.6	1.2	1.5	1.5	1.1	1.5	-	1.2	1.3	1.3
I	52.5	77.5	90.2	73.9	74.5	92.3	67.3	103.7	72.7	92.7	79.7	75.0	83.6	83.6
II	72.5	90.0	92.7	80.4	86.3	103.8	75.0	101.9	85.5	90.9	89.8	90.0	83.6	100.0
III	100.0	112.5	107.3	95.7	92.2	126.9	98.1	118.5	109.1	101.8	100.0	103.3	98.4	108.2
IV	82.5	87.5	87.8	82.6	86.3	100.0	76.9	101.9	94.5	87.3	98.3	86.7	82.0	101.6
TLI	185.0	250.0	341.5	226.1	80.4	213.5	146.2	187.0	123.6	156.4	-	136.7	93.4	167.2
CLI	37.5	55.0	51.2	52.2	39.2	50.0	34.6	33.3	41.8	45.5	-	38.3	41.0	49.2

	M	M	M	M	F	F	F	F	F	F	F	F	F	F
	R-12	R-22	R-14	R-4	R-15	R-5	R-37	R-132	R-1	R-21	R-117	R-112	R-38	R-19
DML	36.5	42.0	44.5	45.0	21.0	24.5	25.0	25.0	27.5	32.0	35.0	37.4	41.0	45.5
VMLI	93.2	97.6	95.5	86.7	85.7	-	86.0	101.2	107.3	95.3	91.4	95.7	90.2	95.6
MWI	68.5	70.2	62.9	75.6	95.2	63.3	86.0	77.6	83.6	68.8	80.0	68.2	73.2	76.9
HLI	63.0	73.8	64.0	64.4	85.7	61.2	72.0	75.6	72.7	57.8	72.9	58.8	64.6	57.1
HWI	74.0	58.3	47.2	62.2	88.1	59.2	82.0	76.0	76.4	57.8	53.1	57.0	-	55.0
FLI	61.6	52.4	48.3	60.0	66.7	49.0	66.0	60.0	61.8	56.3	52.3	69.8	59.8	61.5
FII	47.9	51.2	40.4	53.3	50.0	38.8	48.0	52.8	50.9	46.9	49.4	63.6	47.6	48.4
FWI	139.7	117.9	127.0	137.8	166.7	118.4	152.0	136.4	163.6	126.6	158.0	140.6	136.6	126.4
FWIs	43.8	40.5	36.0	37.8	45.2	34.7	40.0	36.0	47.3	31.3	42.6	43.3	42.7	37.4
FPI	26.0	28.6	19.1	30.0	21.4	42.9	34.0	20.0	43.6	25.0	17.1	28.1	23.2	28.6
SIs	5.5	6.4	5.6	5.6	5.2	3.3	4.0	-	5.1	3.4	4.6	3.7	4.1	4.4
SIt	1.1	1.2	-	0.8	1.4	1.2	1.6	1.4	1.8	1.3	1.1	1.2	1.1	0.9
I	72.6	94.0	82.0	72.2	85.7	57.1	90.0	76.0	65.5	51.6	82.9	65.5	81.7	71.4
II	79.5	107.1	102.2	88.9	85.7	77.6	92.0	88.0	87.3	57.8	101.4	64.2	84.1	79.1
III	94.5	121.4	122.5	104.4	92.9	91.8	114.0	110.0	105.5	78.1	114.3	90.9	111.0	102.2
IV	78.1	114.3	88.8	71.1	92.9	83.7	92.0	90.0	78.2	60.9	91.4	76.2	98.8	84.6
TLI	78.1	225.0	-	154.4	300.0	320.4	298.0	156.0	168.7	125.0	202.9	82.9	300.0	136.3
CLI	35.6	27.4	-	37.8	61.9	49.0	60.0	44.0	47.3	32.8	45.7	36.1	63.4	42.9

Table II. Measurements and indices of specimens of Rossia megaptera treated in Fig. 9.

	M	M	M	M	M	M	M	M	M	M	M	M	M
	R-41	R-46	R-45	R-44	R-119	R-24	R-18	R-31	R-57	R-85	R-79	R-43	R-16
DML	15.7	15.9	18.0	18.2	18.3	19.0	21.0	21.0	21.0	21.8	22.3	24.0	25.5
VMLI	93.0	91.8	111.1	101.6	96.2	94.7	83.3	92.9	89.0	95.0	95.1	94.2	100.0
MWI	79.0	86.8	85.0	89.6	85.8	76.3	76.2	90.5	84.8	87.2	83.9	85.4	88.2
HLI	78.3	77.4	81.1	89.6	69.9	73.7	73.8	76.2	79.5	77.5	74.0	77.1	62.7
HWI	81.5	86.2	91.1	92.3	102.2	78.9	71.4	92.9	88.1	81.2	94.2	88.3	88.2
FLI	61.8	69.2	71.1	80.2	63.4	60.5	71.4	61.9	81.0	67.9	73.1	55.4	74.5
FII	54.8	54.1	57.2	59.3	53.0	57.9	47.6	57.1	61.9	55.0	57.4	54.2	60.8
FWI	161.8	159.1	173.9	174.7	182.5	134.2	135.7	171.4	177.6	157.3	174.0	138.3	164.7
FWIs	52.9	50.3	59.4	54.9	46.4	52.6	45.2	40.5	52.9	43.6	56.5	49.2	39.2
FPI	20.4	12.6	17.2	18.7	22.4	10.5	19.0	21.4	23.8	22.0	17.0	20.8	11.8
SIs	5.1	5.7	7.2	5.5	6.6	3.7	5.7	5.7	7.6	5.0	5.4	8.8	7.1
SIt	0.6	1.9	1.7	1.6	1.1	1.1	1.0	1.0	1.4	1.4	1.3	1.3	1.2
I	79.6	81.8	108.3	98.9	114.8	55.3	83.3	81.0	100.0	82.6	98.7	97.9	86.3
II	76.4	103.8	111.1	101.6	112.0	68.4	-	92.9	100.0	101.0	103.1	97.9	78.4
III	105.1	106.9	130.6	134.6	136.6	76.3	-	102.4	121.4	107.8	130.0	-	102.0
IV	73.2	97.5	100.0	101.6	106.6	65.8	85.7	88.1	109.5	91.7	118.8	104.2	90.2
TLI	191.1	141.5	194.4	162.1	300.5	128.9	288.1	204.8	195.2	142.2	201.8	189.6	129.4
CLI	47.8	50.3	61.1	60.4	68.3	42.1	57.1	59.5	45.2	45.9	53.8	50.0	45.1

	M	M	M	F	F	F	F	F	F	F	F	F	F
	R-30	R-40	R-128	R-9	R-32	R-35	R-27	R-29	R-10	R-123	R-8	R-25	R-131
DML	26.0	30.0	30.0	19.0	21.5	31.0	31.5	33.5	37.5	39.5	40.0	40.5	41.5
VMLI	100.0	89.0	91.7	94.7	104.7	91.9	96.8	88.1	94.7	97.0	100.0	100.0	87.2
MWI	84.6	79.0	81.0	94.7	90.7	82.3	73.0	88.1	88.0	74.9	71.3	69.1	69.4
HLI	80.8	73.0	74.7	71.1	81.4	74.2	74.6	71.6	68.0	62.3	63.8	51.9	62.7
HWI	76.9	86.7	83.7	100.0	97.7	74.2	73.0	80.6	66.7	100.0	88.8	72.8	81.9
FLI	67.3	62.7	78.3	73.7	86.0	71.0	74.6	73.1	80.0	75.9	81.3	64.2	82.4
FII	57.7	57.7	62.3	55.3	65.1	59.7	61.9	61.2	58.7	65.1	62.5	50.6	56.6
FWI	142.3	165.3	166.7	157.9	176.7	164.5	155.6	170.1	165.3	157.8	145.0	128.4	152.3
FWIs	44.2	46.7	48.3	50.0	41.9	50.0	49.2	62.7	48.0	44.8	46.3	32.1	51.8
FPI	21.2	18.0	17.3	23.7	16.3	22.6	19.0	23.9	25.3	12.7	20.0	13.6	14.5
SIs	7.7	6.0	7.3	3.9	5.6	3.5	3.5	4.8	2.1	-	3.5	3.5	4.8
SIt	1.5	1.3	1.3	1.1	0.9	1.0	1.0	0.9	1.3	-	1.0	0.9	1.0
I	105.8	103.3	106.7	65.8	76.7	75.8	79.4	86.6	76.0	98.7	70.0	51.9	77.1
II	80.8	100.0	120.0	89.5	88.4	90.3	87.3	92.5	88.0	106.3	83.8	56.8	98.8
III	96.2	110.0	125.0	121.1	109.3	93.5	101.6	119.4	112.0	115.2	85.0	61.7	110.8
IV	94.2	105.0	120.0	94.7	93.0	80.6	88.9	101.5	81.3	97.5	75.0	59.3	101.2
TLI	165.4	165.0	210.0	226.3	251.2	272.6	274.6	192.5	217.3	194.9	137.5	116.0	178.3
CLI	50.0	51.7	50.0	52.6	60.5	50.0	58.7	47.8	48.0	62.0	46.3	39.5	43.4

Table III. Measurements and indices of specimens of *Rossia molleri* treated in Fig. 9.

	M	M	M	M	M	M	M	M	M	M	M	M	M	M
	RM-7	RM-29	RM-24	RM-14	RM-13	RM-6	RM-31	RM-17	RM-28	RM-3	RM-11	RM-19	RM-30	RM-2
DML	18.0	19.0	19.5	21.0	22.5	22.5	28.5	29.8	30.8	31.2	31.5	32.0	33.0	36.0
VMLI	95.6	95.3	84.6	98.1	86.7	88.0	78.9	93.6	89.3	90.4	86.7	92.5	95.2	93.1
MWI	73.9	70.5	68.2	95.7	88.9	80.0	63.2	69.5	65.6	73.7	75.2	65.0	69.4	65.3
HLI	66.7	66.3	66.7	70.0	71.6	58.7	65.6	54.7	60.7	61.9	72.7	50.0	51.5	51.9
HWI	68.9	68.4	63.1	73.8	54.7	71.6	64.6	68.5	67.5	69.9	68.3	58.4	75.8	58.1
FLI	58.3	60.5	56.4	62.4	53.8	65.3	66.0	61.4	64.9	57.7	55.6	57.8	52.4	53.1
FII	46.7	49.5	44.1	47.1	45.8	52.0	53.7	50.7	46.4	48.1	46.3	45.3	45.5	45.6
FWI	141.7	143.7	137.4	166.7	164.0	153.3	144.9	148.3	129.9	134.9	116.7	126.6	128.5	111.4
FWIs	38.3	42.1	39.5	43.3	55.1	50.7	46.3	59.7	38.3	38.1	49.5	40.6	40.0	27.8
FPI	27.8	25.3	28.2	31.4	26.7	28.4	32.6	26.2	25.3	24.7	34.3	23.1	37.0	25.0
SIs	2.8	3.7	3.1	3.3	2.7	3.1	3.9	3.4	3.9	4.8	4.1	2.8	4.2	4.2
SIt	2.8	2.6	3.1	-	-	3.1	4.2	4.7	4.5	4.8	-	3.8	4.8	4.7
I	63.9	-	74.4	78.6	91.1	-	84.2	67.1	77.9	84.0	92.1	78.1	97.0	78.9
II	86.1	-	71.8	100.0	111.1	82.2	98.2	100.7	97.4	99.4	114.3	93.8	-	73.6
III	97.2	89.5	82.1	119.0	117.8	93.3	101.8	100.7	87.7	92.9	133.3	93.8	106.1	92.2
IV	69.4	84.2	76.9	85.7	88.9	82.2	84.2	85.6	89.3	88.1	117.5	89.1	97.0	86.1
TLI	127.8	131.6	230.8	323.8	440.0	160.0	161.4	134.2	149.4	97.8	333.3	87.5	118.2	123.6
CLI	36.1	44.7	41.0	57.1	53.3	82.2	52.6	50.3	29.2	50.3	63.5	37.5	36.4	34.2

	M	M	F	F	F	F	F	F	F	F	F	F	F	F
	RM-15	RM-4	RM-32	RM-12	RM-20	RM-23	RM-5	RM-1	RM-10	RM-18	RM-16	RM-9	RM-27	RM-8
DML	41.6	42.3	18.7	25.5	26.2	26.8	27.5	30.4	32.0	36.4	37.5	38.0	40.0	55.9
VMLI	96.6	91.0	95.2	74.5	89.7	93.3	96.4	91.4	79.1	90.1	92.8	84.5	88.8	78.9
MWI	58.9	70.2	81.8	89.0	77.9	66.4	89.1	87.2	82.5	69.8	68.0	85.8	64.0	71.6
HLI	64.2	46.3	59.9	71.0	64.9	59.0	60.0	68.4	66.9	56.3	54.9	72.6	55.0	62.6
HWI	62.5	64.3	79.1	65.9	77.1	67.5	70.9	78.0	60.0	65.7	71.5	67.6	64.5	49.0
FLI	55.8	66.9	66.3	60.0	67.6	69.4	67.3	73.4	58.1	67.9	70.1	67.6	62.3	51.3
FII	48.1	50.6	50.3	45.1	50.4	56.0	54.5	60.2	52.8	51.4	53.3	53.2	50.0	45.1
FWI	126.2	138.8	145.5	161.6	144.7	143.7	156.4	156.9	152.2	142.9	143.2	160.5	133.3	141.3
FWIs	36.5	45.2	40.1	39.2	52.3	37.7	43.6	37.8	42.2	47.5	46.7	48.7	38.8	41.1
FPI	24.0	27.2	29.9	26.7	32.8	20.1	29.1	28.6	28.1	27.5	25.1	32.9	30.0	28.8
SIs	3.8	4.5	3.7	3.1	3.1	3.4	3.6	3.6	3.1	2.7	3.7	3.4	3.5	2.7
SIt	3.8	-	3.7	3.9	4.2	4.9	5.1	5.9	-	4.9	6.7	5.3	5.0	4.1
I	88.9	107.6	66.8	98.0	99.2	74.6	81.8	84.5	98.4	98.9	93.3	80.3	77.5	76.7
II	101.0	118.2	74.9	107.8	106.9	97.0	83.6	98.4	118.8	98.9	104.0	125.0	87.5	85.5
III	98.6	112.3	-	127.5	124.0	89.6	87.3	105.3	143.8	116.8	112.0	132.9	88.8	83.2
IV	90.1	96.9	77.5	102.0	106.9	95.1	90.9	91.1	101.6	90.7	94.7	118.4	75.0	71.2
TLI	132.2	-	149.7	368.6	276.7	205.2	118.2	153.3	317.2	274.7	186.7	310.5	110.0	237.9
CLI	40.9	-	43.9	70.6	57.3	59.7	54.5	49.3	68.8	52.2	53.3	80.3	42.5	56.2

Table IV. Measurements and indices of specimens of Rossia pacifica treated in Fig. 9.

	M	M	M	M	M	M	M	M	M	M	M	M	M	M
	RP-6	RP-28	RP-19	RP-26	RP-23	RP-17	RP-24	RP-27	RP-22	RP-10	RP-2	RP-5	RP-1	RP-3
DML	23.5	23.5	23.5	23.9	24.4	25.7	27.0	28.0	28.4	30.0	32.7	36.9	38.2	44.4
VMLI	94.9	91.9	94.9	90.8	93.4	93.4	87.0	83.2	92.6	97.7	97.2	93.8	94.2	93.5
MWI	70.6	68.1	69.8	74.5	72.5	76.3	74.8	72.9	73.6	79.0	71.9	63.4	92.7	86.7
HLI	55.7	56.2	53.6	54.4	59.4	58.0	52.2	58.9	65.5	53.3	55.7	47.4	52.9	48.4
HWI	71.5	68.1	68.5	78.2	68.0	65.8	53.7	74.6	75.7	75.0	68.2	68.8	60.7	70.9
FLI	62.6	59.6	-	68.2	66.0	73.9	61.1	63.2	73.9	62.7	63.6	54.2	66.0	71.8
FII	50.6	46.8	-	52.3	52.0	58.4	50.7	57.9	55.3	50.7	53.5	45.8	58.4	57.9
FWI	146.0	134.9	-	131.8	130.7	110.9	140.4	125.7	142.6	135.0	129.1	108.4	144.0	134.0
FWIs	38.3	31.9	-	41.0	50.0	46.3	35.6	30.4	41.5	42.7	37.3	30.9	37.4	31.8
FPI	30.2	31.5	-	26.4	23.4	24.5	25.6	25.0	28.9	22.2	20.8	22.5	25.7	38.7
SIs	5.1	5.5	6.0	7.9	7.4	-	6.3	6.4	8.1	6.3	6.7	5.4	5.5	6.1
SIt	1.7	0.9	2.1	2.1	2.5	-	2.6	2.1	2.5	1.3	1.8	1.4	1.3	1.6
I	95.7	-	93.6	104.6	102.5	97.3	103.7	75.0	109.2	106.7	111.6	78.6	123.0	111.5
II	100.0	106.4	110.6	113.0	114.8	108.9	114.8	142.9	121.5	133.3	123.9	94.9	136.1	112.6
III	108.5	110.6	112.8	125.5	102.5	120.6	129.6	132.1	133.8	131.7	122.3	100.3	145.3	130.6
IV	93.6	93.6	89.4	110.9	98.4	105.1	105.6	121.4	123.2	123.3	107.0	94.9	130.9	112.6
TLI	117.0	234.0	110.6	138.1	155.7	217.9	144.4	153.6	93.3	123.3	125.4	103.0	104.7	89.0
CLI	46.8	63.8	51.1	52.3	45.1	54.5	51.9	60.7	56.3	56.7	55.0	50.1	57.6	43.9

	F	F	F	F	F	F	F	F	F	F	F	F	F	F
	RP-12	RP-21	RP-14	RP-20	RP-18	RP-13	RP-25	RP-11	RP-16	RP-8	RP-9	RP-7	RP-4	RP-15
DML	13.7	20.1	21.3	23.0	24.5	25.5	26.3	28.6	30.1	39.6	39.8	41.0	41.7	49.1
VMLI	86.1	94.5	96.2	91.3	91.0	91.0	97.0	93.7	92.4	101.8	98.5	87.3	89.9	88.4
MWI	94.9	88.1	85.4	73.9	77.6	82.0	77.2	75.5	73.1	72.5	74.9	67.1	85.6	70.3
HLI	57.7	63.2	60.1	50.9	51.0	56.9	55.1	51.7	50.5	50.5	42.2	48.8	54.4	47.3
HWI	79.6	80.1	77.0	69.6	65.7	71.4	80.2	73.4	50.2	64.9	76.1	61.0	70.7	56.6
FLI	69.3	72.1	70.0	60.9	72.2	68.2	104.2	65.0	65.4	69.2	72.1	69.5	65.2	61.7
FII	49.6	57.7	53.1	50.9	60.8	54.1	54.8	50.3	52.8	53.8	55.3	50.5	54.7	48.9
FWI	136.5	160.7	153.1	133.0	143.3	146.7	130.0	131.8	131.6	146.5	137.7	137.6	140.3	121.0
FWIs	38.0	46.3	41.8	46.1	42.0	36.5	58.6	35.7	33.6	44.9	43.2	64.6	36.7	36.5
FPI	27.7	26.9	23.0	34.3	24.5	22.4	20.9	19.9	24.9	25.3	21.4	19.8	24.0	33.2
SIs	2.9	5.0	4.7	4.3	4.5	4.7	4.6	4.2	4.3	4.3	3.5	4.4	4.6	3.1
SIt	1.5	2.5	2.8	2.6	2.9	2.0	2.3	2.4	2.3	3.0	2.8	2.4	2.6	1.4
I	58.4	84.6	58.7	80.4	91.8	78.4	89.4	87.4	86.4	79.5	62.8	85.4	98.3	78.4
II	80.3	104.5	93.9	93.5	102.0	94.1	119.8	108.4	99.7	107.3	87.9	98.8	118.7	82.5
III	62.0	111.9	103.3	110.9	106.1	92.2	116.0	111.9	101.3	106.1	80.4	97.6	115.1	91.6
IV	58.4	104.5	105.6	95.7	102.0	74.5	106.5	103.1	103.0	97.2	103.0	87.8	107.9	79.4
TLI	204.4	261.2	164.3	187.0	228.6	117.6	220.5	73.4	219.3	99.7	105.5	101.2	143.9	137.5
CLI	51.1	64.7	51.6	43.5	57.1	47.1	55.1	52.4	63.1	53.0	47.7	42.7	62.4	46.8