Marine Biodiversity Records, page 1 of 4.
doi:10.1017/S1755267214000645; Vol. 7; e58; 2014 Published online

The northernmost record of *Sepietta oweniana* (Cephalopoda: Sepiolidae) and comments on boreo-subtropical cephalopod species occurrence in the Arctic

ALEXEY V. GOLIKOV[1], RUSHAN M. SABIROV[1], PAVEL A. LUBIN[2], LIS L. JØRGENSEN[3] AND INGER-MARIE BECK[4]

[1]Department of Invertebrate Zoology, Kazan Federal University, 420008 Kazan, Russia, [2]Laboratory of Coastal Research, Polar Research Institute of Marine Fisheries and Oceanography, 183038 Murmansk, Russia, [3]Institute of Marine Research, PO Box 6404 NO-9294 Tromsø, Norway, [4]Institute of Marine Research, PO Box 1870 Nordnes, NO-5817 Bergen, Norway

The first observation of the common bobtail squid Sepietta oweniana *has been made in the Barents Sea (Tromsø Bank; 70°54′N 19°46.8′E). It is the northernmost area of this species distribution. No changes were found in the reproductive system structure. But the food spectrum was changed, particularly, juvenile fish of the Lotidae family was found. The bobtail squid of the Sepiolinae subfamily have never been recorded as fish eaters previously. The expansion of boreo-subtropical species of cephalopods into the Arctic during the last decade can be divided into two groups: (1) a foraging migration happening relatively regularly; and (2) a range expansion due to the ongoing Arctic warming. The case of* S. oweniana *obviously belongs to the second group.*

Keywords: *Sepietta oweniana*, Sepiolidae, feeding, food spectrum, female reproductive system, the Barents Sea, Arctic warming

Submitted 12 April 2014; accepted 19 May 2014

INTRODUCTION

Common bobtail squid *Sepietta oweniana* (d'Orbigny, 1841) inhabits the eastern Atlantic Ocean and the Mediterranean Sea. The biology of *S. oweniana* is well known and summarized in Reid & Jereb (2005). Despite several papers on this species' reproductive biology (Bello & Deickert, 2003; Deickert & Bello, 2005; Cuccu *et al.*, 2010; Czudaj *et al.*, 2012) and feeding (Bergstrøm, 1985; Orsi Relini & Massi, 1988), these aspects are still insufficiently studied, especially in northern parts of its range. The northern border of the species range is ~70°N on the Norwegian shelf (Grimpe, 1933; Bergstrøm & Summers, 1983). The ongoing warming of the Arctic (Walther *et al.*, 2002; Walczowski & Piechura, 2006; Walsh, 2008) induces the subsequent spreading of boreal and boreo-subtropical Atlantic species of fish and invertebrates into this area (Berge *et al.*, 2005; Johannesen *et al.*, 2012; Nekhaev, 2013). A northward expansion of North Atlantic cephalopods into the Arctic might be expected, and it is already described for some species of squid (Sabirov *et al.*, 2012; Golikov *et al.*, 2013).

The main purpose of this paper is to report the northernmost record of *S. oweniana*, to describe its reproductive system and feeding in the new area of distribution. The occurrence of this species in the Barents Sea and the ongoing processes of the Arctic warming are also discussed.

Corresponding author:
A.V. Golikov
Email: golikov_ksu@mail.ru

MATERIALS AND METHODS

A single specimen of *Sepietta oweniana* was captured in the Tromsø Bank (70°54′N 19°46.8′E; depth 175 m) (Figure 1) by a demersal trawl on-board RV 'G.O. Sars' on 17 September 2013 at about 2:30 a.m. Species identification was performed according to the criteria of Nesis (1987) and Reid & Jereb (2005). The specimen is kept in the Zoological Museum of Kazan Federal University (Kazan, Russia). Mantle length (ML), total body length (TBL) and body weight (BW) were measured, maturity stage and stomach fullness were determined, followed by the detailed analysis of reproductive system as well as measuring and examination of some parts of digestive system. The relative length and weight were calculated for the most of the measurements taken. The scale of maturity stages was modified from Lipinski & Underhill (1995) and the scale of stomach fullness was used from Breiby & Jobling (1985). The analysis of the stomach content was performed, and prey remains were determined to the nearest possible taxonomic group.

RESULTS

The new record of *Sepietta oweniana* was located at the Tromsø Bank, which is ~100 km north-east of the recent known northern border of the species range. This area is influenced by the North Cape Current, and the mean annual bottom temperature exceeds here +6°C (Jakobsen & Ozhigin, 2012).

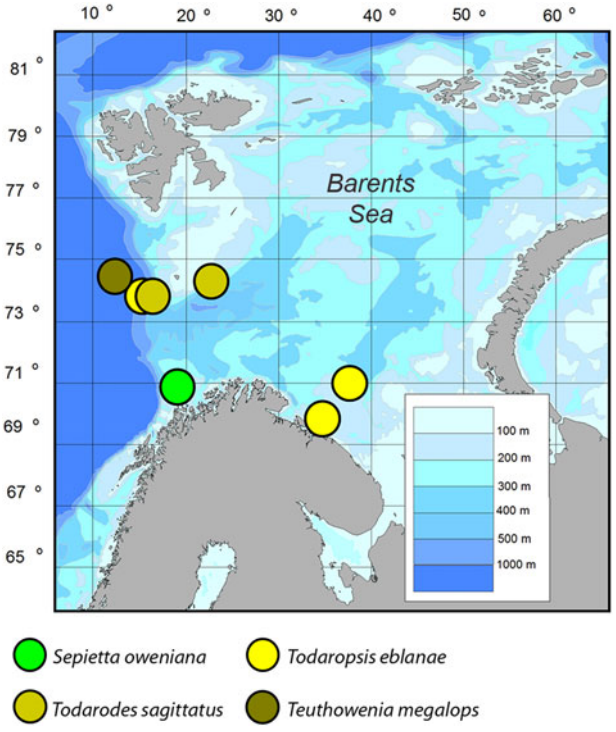

Fig. 1. The occurrence of boreo-subtropical species of cephalopods in the Barents Sea and adjacent areas.

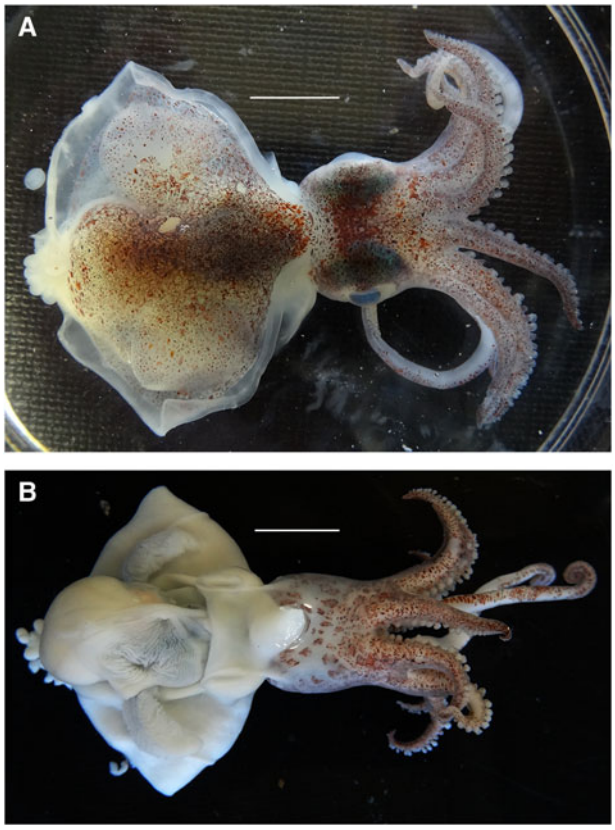

Fig. 2. *Sepietta oweniana*, maturing female, mantle dissected: (A) dorsal view; (B) ventral view. Scale bar: 1 mm.

The specimen had ML 28 mm, TBL 59 mm and BW 3.7 g. Its arms had biserial suckers. Tentacular clubs were with 32 tiny uniform-sized suckers in transverse rows. Bursa copulatrix was almost square with sizes 10 × 8.5 mm, covering most of the left side of the mantle cavity (Figure 2). The specimen was a maturing female at maturity stage IV. The relative weight of the whole reproductive system was 11.73% BW and the relative weight of the ovary was 2.51% BW. In the ovary, 408 oocytes were found, over 95% of them at a previtellogenetic phase. Among vitellogenetic oocytes, the largest ones were 3.3 mm in diameter (1.2% ML). No atretic oocytes were observed. No spermatangia were found in the bursa copulatrix.

Stomach fullness was at the stage '1–2' (almost half full). Stomach length was 9.4 mm and its weight was 0.044 g. The relative weight of the stomach content was 0.76% BW, and consisted of unidentifiable organic matter (50%), and fatty substance and drops (8%). The remaining 42% were fragments of Crustacea making up more than 150 pieces of shell and appendages. Mysids (order Mysida) were identified by the shape and structure of mandibles (one pair), antennal scale (one piece) and uropods (one pair). Nine cycloid scales were found; mean diameter 0.7 mm. They were identified to a juvenile ling fish (family Lotidae) with body length in the range of 10 to 15 mm. It is less than 25% TBL of sampled *S. oweniana*. Fish eating has never been recorded for the bobtail squid of the Sepiolinae subfamily previously (Boletzky *et al.*, 1971; Reid & Jereb, 2005). Caecum length was 10.9 mm and its weight was 0.076 g. Unidentifiable organic matter, making up twice as much weight as the whole stomach content, was recorded inside the caecum. Sepiolinae feed at night (Boletzky *et al.*, 1971; Bergstrøm, 1985; Orsi Relini & Massi, 1988) and have fast digestion rates (Bidder, 1966). So the caecum content must have been eaten the same night that the sepioline squid was captured. Therefore, its last meal consisted of 2–3 mysids and one juvenile ling fish. The active feeding of the *S. oweniana* specimen at the Tromsø Bank was also indicated by a large relative weight of liver (8.73% BW).

DISCUSSION

Sepietta oweniana was recorded in the south-western part of the Barents Sea for the first time. This area is influenced by the incoming Atlantic waters. Their warming was confirmed by many evidences (Walther *et al.*, 2002; Walczowski & Piechura, 2006; Walsh, 2008). In the same area of the Barents Sea, three boreal-subtropical species of squid were recorded (Figure 1). Two of them, *Teuthowenia megalops* (Prosch, 1847) and *Todaropsis eblanae* (Ball, 1841), are not active nekton swimmers, and their occurrence in this northern area must include diffuse spreading due to warming. The observed abnormalities within the maturation process indicate that new parts of their ranges are the zones of non-reproductive spreading (Sabirov *et al.*, 2012; Golikov *et al.*, 2013). The hydrological preferences of *Todarodes sagittatus* (Lamarck, 1798) migrations into the Arctic are not reported. Foraging shoals of immature squid occur quite regularly within intervals from 1 to 27 years (Wiborg *et al.*, 1982; Golikov *et al.*, 2013).

The occurrence of *S. oweniana* in the Tromsø Bank is connected mainly with warming, and is supposed to have happened quite often during the last decade. The food preference

of *S. oweniana* can also be changed in the new northern area. In particular, it included ling fish, as shown by scales in its stomach. Sepiolinae are known to capture only alive prey (Boletzky *et al.*, 1971; Reid & Jereb, 2005). However laboratory studies showed that, even in low prey abundance, *S. oweniana* did not attack offered fish with body length about 2/3 TBL (Bergstrøm, 1985). Nevertheless our specimen of *S. oweniana* captured the juvenile ling fish with a body length about 1/4 TBL (fish size had been estimated according to the diameter of fish scales).

No abnormalities were recorded in the reproductive system structure of the captured specimen. Its ML corresponded to ML of maturing females in the North Sea. Fecundity also lay within known values recorded for *S. oweniana*, varying from 106 to 1613 eggs (Bergstrøm & Summers, 1983; Bello & Deickert, 2003; Reid & Jereb, 2005; Cuccu *et al.*, 2010; Czudaj *et al.*, 2012). Considering short duration of the life cycle of *S. oweniana* (no more than 9 months) (Reid & Jereb, 2005), our specimen could reach the maturation in late autumn, during the period of low mean annual bottom temperatures (less than +5°C) (Jakobsen & Ozhigin, 2012). It seems unlikely that sepioline can realize their reproductive efforts in such environmental conditions.

Thus, all the reported records of boreo-subtropical cephalopods in the Arctic can be divided into two groups:

1. Foraging migrations happening regularly and take place during an unknown period of and without any connection with the warming (*T. sagittatus*).
2. Expansions induced by the ongoing Arctic warming have taken place during the current decade (*S. oweniana*, *T. megalops* and *T. eblanae*). These Atlantic species of cephalopods are carried by warm currents into the Arctic, where they either lose the reproductive functions or cannot realize them.

ACKNOWLEDGEMENTS

We thank scientific group and crew of RV 'G.O. Sars' during the ecosystem cruise in September 2013, for their assistance on-board. Also we are grateful to Dr R. Burukovsky for his advices on stomach content analysis and Dr F. Gizatullin for improving the English language. The valuable comments of two anonymous referees are gratefully acknowledged. This research was partly supported by the Norwegian–Russian Program of the Barents Sea ecosystem survey.

REFERENCES

Bello G. and Deickert A. (2003) Multiple spawning and spawning batch size in *Sepietta oweniana* (Cephalopoda: Sepiolidae). *Cahiers de Biologie Marine* 44, 307–314.

Berge J., Johnsen G., Nilsen F., Gulliksen B. and Slagstad D. (2005) Ocean temperature oscillations enable reappearance of blue mussels *Mytilus edulis* in Svalbard after a 1000 year absence. *Marine Ecology Progress Series* 303, 167–175.

Bergstrøm B. (1985) Aspects of natural foraging by *Sepietta oweniana* (Mollusca, Cephalopoda). *Ophelia* 24, 65–74.

Bergstrøm B. and Summers W.C. (1983) *Sepietta oweniana*. In Boyle P.R. (ed.) *Cephalopod life cycles. Volume 1. Species accounts*. London: Academic Press, pp. 75–91.

Bidder A.M. (1966) Feeding and digestion in cephalopods. In Wilbur K.M. and Yonge C.M. (eds) *Physiology of Mollusca. Volume II*. New York and London: Academic Press, pp. 97–124.

Boletzky S. von, Boletzky M.V. von, Frosch D. and Gatzi V. (1971) Laboratory rearing of Sepiolinae (Mollusca: Cephalopoda). *Marine Biology* 8, 82–87.

Breiby A. and Jobling M. (1985) Predatory role of the flying squid (*Todarodes sagittatus*) in North Norwegian waters. *North Atlantic Fisheries Organization Scientific Council Studies* 9, 125–132.

Cuccu D., Mereu M., Cannas R., Marcias S., Cau A. and Jereb P. (2010) An unusual finding of *Sepietta oweniana* (Cephalopoda: Sepiolidae) egg clutch. *Scientia Marina* 74, 555–560.

Czudaj S., Pereira J.O., Moreno A., Costa A.M., Saint-Paul U. and Rosa R. (2012) Distribution, abundance, reproduction and ageing of the common bobtail squid *Sepietta oweniana* (Sepiolidae, Cephalopoda) from the Portuguese coast. *Marine Biology Research* 8, 74–86.

Deickert A. and Bello G. (2005) Egg masses of *Sepietta oweniana* (Cephalopoda: Sepiolidae) collected in the Catalan Sea. *Scientia Marina* 69, 205–209.

Golikov A.V., Sabirov R.M., Lubin P.A. and Jørgensen L.L. (2013) Changes in distribution and range structure of Arctic cephalopods due to climatic changes of the last decades. *Biodiversity* 14, 28–35.

Grimpe G. (1933) Die cephalopoden des arktischen gebietes. *Fauna Arctica* 6, 489–514.

Jakobsen T. and Ozhigin V. (2012) *The Barents Sea: ecosystem, resources, management. Half a century of Russian–Norwegian cooperation*. Trondheim: Tapir Academic Press.

Johannesen E., Høines A.S., Dolgov A.V. and Fossheim M. (2012) Demersal fish assemblages and spatial diversity patterns in the Arctic–Atlantic transition zone in the Barents Sea. *PLoS ONE* 7, e34924. doi:10.1371/journal.pone.0034924.

Lipinski M.R. and Underhill L.G. (1995) Sexual maturation in squid: quantum or continuum? *South African Journal of Marine Science* 15, 207–223.

Nekhaev I.O. (2013) The first record of *Alvania punctura* from Russian waters (Gastropoda: Rissoidae). *Marine Biodiversity Records* 6, e2. doi:10.1017/S1755267212001145.

Nesis K.N. (1987) *Cephalopods of the world: squid, cuttlefish, octopuses and their allies*. Neptune City, NJ: T.F.H. Publications.

Orsi Relini L. and Massi D. (1988) Feeding of *Sepietta oweniana* (d'Orbigny 1839) along the slope of the Ligurian Sea: a preliminary note. *Rapport Commission International Mer Méditerranée* 31, 255.

Reid A. and Jereb P. (2005) Family Sepiolidae. In Jereb P. and Roper C.F.E. (eds) *FAO Species Catalogue for Fishery Purposes, No. 4: Cephalopods of the world. An annotated and illustrated catalogue of species known to date. Volume 1. Chambered nautiluses and sepioids (Nautilidae, Sepiidae, Sepiolidae, Sepiadariidae, Idiosepiidae and Spirulidae)*. Rome: FAO, pp. 153–203.

Sabirov R.M., Golikov A.V., Nigmatullin Ch.M. and Lubin P.A. (2012) Structure of the reproductive system and hectocotylus in males of lesser flying squid *Todaropsis eblanae* (Cephalopoda: Ommastrephidae). *Journal of Natural History* 46, 1761–1778.

Walczowski W. and Piechura J. (2006) New evidence of warming propagating toward the Arctic Ocean. *Geophysical Research Letters* 33, L12601. doi:10.1029/2006GL025872.

Walsh J.E. (2008) Climate of the arctic marine environment. *Ecological Applications* 18 (Supplement), 3–22.

Walther G.-R., Post E., Convey P., Menzel A., Parmessan C., Beebee T.J.C., Fromentin J.-M., Hoegh-Guldberg O. and Bairlein F. (2002) Ecological responses to recent climate change. *Nature* 416, 389–395.

and

Wiborg K.F., Gjøsaeter J. and Beck I.M. (1982) *The squid* Todarodes sagittatus *(Lamarck); distribution and biology in northern waters, August 1981–April 1982*. International Council for the Exploration of the Sea (CM Papers and Reports), CM 1982/K: 30, 17 pp.

Correspondence should be addressed to:
A.V. Golikov
Department of Invertebrate Zoology
Kazan Federal University
420008, Kremlyovskaya str. 18, Kazan, Russia
email: golikov_ksu@mail.ru