

**TRICHOTROPIS BICARINATA (GASTROPODA) FROM THE PLIO-PLEISTOCENE  
KAP KØBENHAVN FORMATION, NEW TO THE FOSSIL FAUNA OF GREENLAND**

by

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About two million years ago, forest-tundra vegetation existed adjacent to the Arctic Ocean in the northernmost land areas on Earth. By extrapolation of climatic inferences based on palaeo-vegetation, the Arctic Ocean was warmer than today and not perennially ice covered. These implications are confirmed by the presence of extralimital, southern marine molluscs.

This paper documents the occurrence of the gastropod *Trichotropis bicarinata* (Sowerby, 1825) in the Kap København Formation, and maps the known modern and fossil range of this species.

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**SAMENVATTING**

*Trichotropis bicarinata* (Gastropoda) uit de Plio-Pleistocene Kap København Formatie, nieuw voor de fossiele fauna van Groenland.

Ongeveer twee miljoen jaar geleden bestonden er, grenzend aan de Noordelijke IJszee, bos-toendra-vegetaties in de meest noordelijke landstreken van de aarde. Extrapolatie van klimatologische conclusies gebaseerd op de palaeo-vegetatie toont aan dat de Noordelijke IJszee warmer was dan heden ten dage en niet voortdurend met ijs bedekt. Deze gevolgtrekkingen worden bevestigd door de aanwezigheid van zuidelijke mariene mollusken, van buiten het tegenwoordige faunagebied.

Dit artikel toont de aanwezigheid van de gastropode *Trichotropis bicarinata* (Sowerby, 1825) aan in de Kap København Formatie, en brengt de nu bekende tegenwoordige en fossiele verspreiding van die soort in kaart.

## INTRODUCTION

The Kap København Formation, which is about 2-2.5 Ma old, is situated in eastern North Greenland at latitude 82°30'N (Fig. 1). The formation is of great palaeoclimatological and palaeogeographical importance because it is the only sedimentary sequence from this time interval known

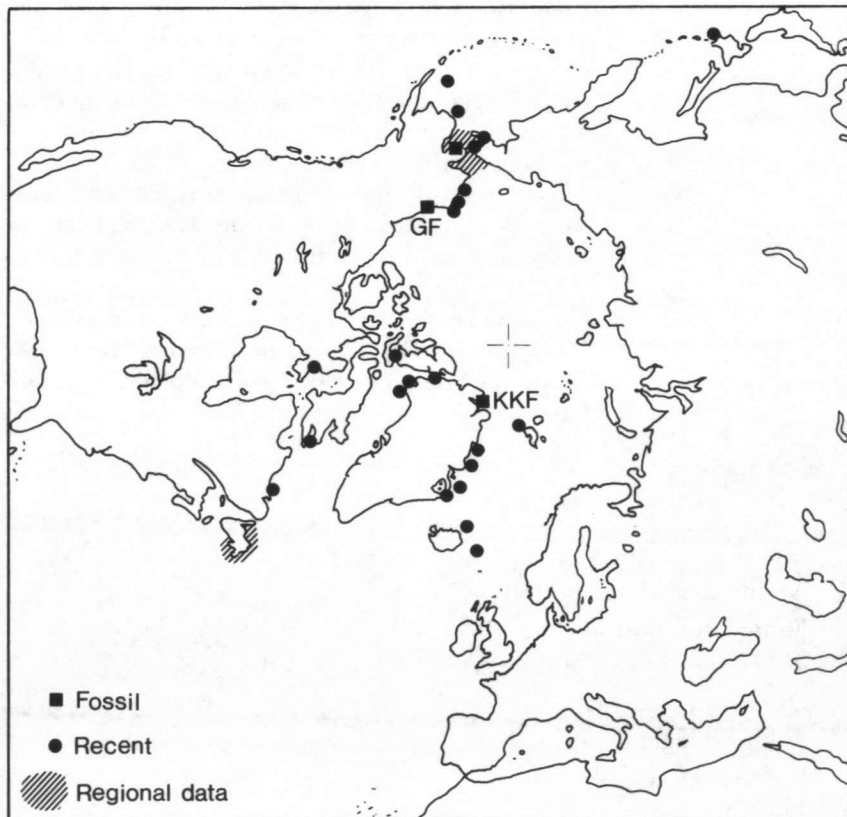


Fig. 1. Map showing the modern range of *Trichotropis bicarinata* based on Dall (1872), Friele (1903), Golikov (1964), Grieg (1907, 1909), Hägg (1905), Hirase & Taki (1951), Krause (1885), Macpherson (1971), MacGinitie (1959), Middendorf (1851), Smith (1877), Sowerby (1825) and Thorson (1941, 1944, 1951), its fossil occurrences, the positions of the Kap København Formation (KKF) in north Greenland and of the Gubik Formation (GF) in northern Alaska.

so far North. The formation consists of clay, silt and sand deposited in sublittoral and littoral waters. It contains autochthonous marine faunas and allochthonous remains of land and freshwater plants and animals.

A detailed account of the remains of vascular plants is in press (Bennike, in press). The macroscopic plant remains comprise a mixture of forest and tundra plants, and points to forest-tundra vegetation in the area during the deposition of the formation. Among the boreal plants may be mentioned *Larix groenlandii* Bennike, *Picea mariana* (Mill.) B. S. P., *Thuja occidentalis* L., *Cornus* spp. and *Viburnum* cf. *edule* (Michx.) Raf.

Most notable among the arctic plants is *Dryas octopetala* L. About 60 taxa of vascular plants are represented by macroscopic remains. Floral composition and growth ring analyses suggest a mean temperature for the warmest month of the year slightly above 10°C. The corresponding modern figure for Kap København is 3°C, so the climate was much warmer during the time of deposition than today. The insect fauna of the formation comprises at least 100 species (Böcher, 1989; Bennike & Böcher, in press). The fossil insect fauna is dominated by beetles, most of which are extant, boreal species that do not live in Greenland today.

The marine fauna consists of foraminifers, ostracodes, barnacles and molluscs. Some information on the foraminiferal fauna was published by Funder *et al.* (1985) and Feyling-Hanssen (1986, 1987), while some notes on the molluscs can be found in Funder & Hjort (1980), Funder *et al.* (1984, 1985, 1987) and Bennike (1987 and in press). The aim of this paper is to document the occurrence of *Trichotropis bicarinata* (Sowerby, 1825) in the formation.

The dating of the deposit is primarily based on biostratigraphical correlations (mammals, foraminifers, molluscs and ostracodes) (Funder *et al.*, 1985; Repenning *et al.*, 1987; Bennike, in press; Brouwers *et al.*, in press; Feyling-Hanssen, in press), and secondarily on palaeomagnetic analyses (Abrahamsen & Marcussen, 1986).

#### AMINO ACID DATA

The fossil mollusc fauna was found in a small exposure along a river during fieldwork in 1986 (locality 128 of Bennike, in press). The locality is geographically isolated from the rest of the Kap København Formation, being situated to the northeast of the main area of the formation. Because the mollusc and foraminifer faunas (R. W. Feyling-Hanssen, pers. comm.) at this locality differ somewhat from those of the rest of the Kap København Formation, three shells of the bivalve *Hiatella arctica* (L., 1767) were analysed with respect to the alloisoleucine/isoleucine ratio. The ratio between these two isomers is primarily dependent on time and temperature, and is thus a strong correlation tool within limited areas (*e.g.* Miller & Mangerud, 1985). The results of the analyses appear in Table

Lab. No.	Total*	Free
AAL-5072	0.123	0.85
	0.172	0.83
	0.171	0.82

\*: Free and peptide-bound amino acids

Table 1. Alloisoleucine/isoleucine ratios in 3 shells

1. According to Funder *et al.* (1987) alloisoleucine/isoleucine ratios from the Kap København Formation average 0.1560.033 and 0.8050.151 in the total and free fraction, respectively. Although the results from the new locality show a large variation, the similarity in the alloisoleucine/isoleucine ratios does not contradict that the locality belongs to the Kap København Formation.

## FAUNAL COMPOSITION

In addition to *Trichotropis bicarinata*, a number of bivalves and other gastropods were identified from the locality (Table 2). The shells are well preserved and of normal thickness - in contrast to shells from other outcrops of the Kap København Formation, which are extremely thin and usually crushed. The fossil fauna from the new locality indicates shallow sublittoral euryhaline waters during deposition. Many of the species are extralimital, southern species, thus *Macoma balthica* has a modern

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<i>Trichotropis bicarinata</i> (Sowerby, 1825)
<i>Natica clausa</i> Broderip & Sowerby, 1829
<i>Boreotrophon truncatus</i> (Ström, 1767)
<i>Colus</i> sp.
<i>Buccinum</i> sp.
<i>Oenopota</i> spp.
<i>Nuculana pernula</i> (Müller, 1779)
<i>Portlandia intermedia</i> M. Sars, 1865
<i>Actinula greenlandica</i> (Sowerby, 1842)
<i>Astarte borealis</i> Schumacher, 1817
<i>Astarte montagui</i> (Dillwyn, 1817)
<i>Serripes groenlandicus</i> (Bruguière, 1789)
<i>Clinocardium ciliatum</i> (Fabricius, 1780)
<i>Macoma balthica</i> (Linné, 1758)
<i>Macoma calcarea</i> (Gmelin, 1791)
<i>Hiatella arctica</i> (Linné, 1767)
<i>Mya truncata</i> Linné, 1758

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Table 2. List of molluscs in the sample (GCI 53255).

northern limit in the eastern North Atlantic off central West Greenland, latitude 72°N (Posselt & Jensen, 1898). *Clinocardium ciliatum*, *Serripes groenlandicus* and *Boreotrophon truncatus* probably do not occur along the shores of eastern North Greenland today (Schjøtte, 1989; Bennike *et al.*, 1986). The bivalve *Cyrtodaria kurriana* Dunker, 1862 is a dominant element of the mollusc fauna of the Kap København Formation, but this species was not found in the discussed sample. According to Nesis (1965), *Cyrtodaria kurriana* may be an indicator of lowered salinity, a factor which could also explain the unusually thin shells characteristic of the Kap København Formation. That fresh water did indeed influence the area is clearly shown by the abundance of terrestrial organic matter in the formation.

### *TRICHOTROPIS BICARINATA* (SOWERBY, 1825) (Fig. 2.)

The species was first described by Sowerby (1825) as *Turbo bicarinata*. Broderip & Sowerby (1829) erected the genus *Trichotropis*, and placed *Turbo bicarinata* in this genus. *Trichotropis sowerbiensis*

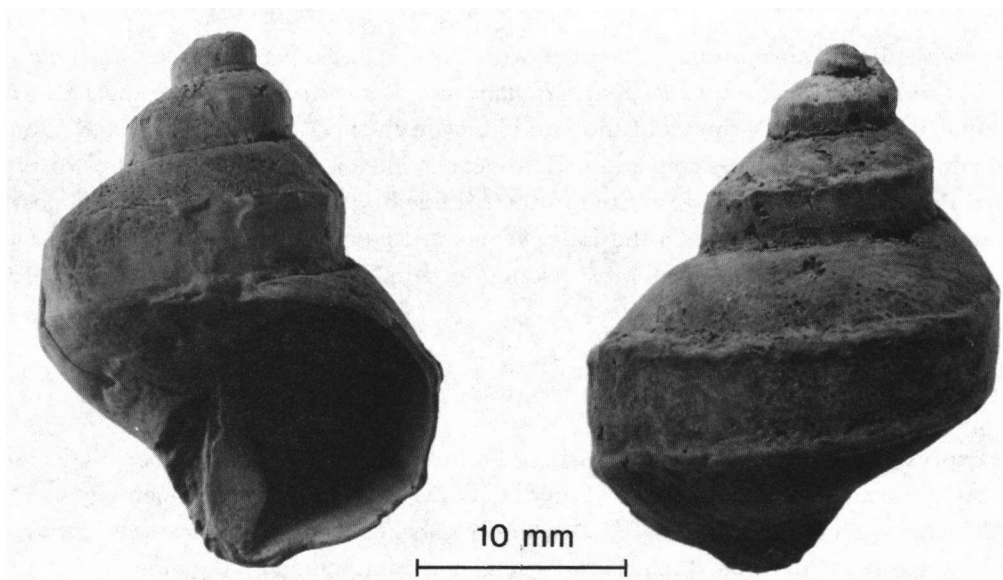


Fig. 2. *Trichotropis bicarinata* (Sowerby, 1825). MGUH 19476 from GCI 53255, Plio-Pleistocene, North Greenland.

Lesson, 1832, *T. tenuis* Smith, 1877 and *T. hjorti* Friele, 1888 are usually considered synonyms. *T. (bicarinata var.?) alta* Dall, 1872 and *T. (bicarinata var.?) spectabilis* Dall, 1872 are also considered synonyms herein. Each of these varieties was based on a single specimen (Dall, 1872).

*Material* — A single slightly fragmented specimen.

*Remarks* — The shell is thick, it measures 24.9 mm in height and 18.8 mm in maximum diameter. There are four whorls which enlarge rapidly. The body whorl has two prominent spiral ribs, but otherwise the shell lacks sculpture. There is a short canal at the base of the aperture. It is noteworthy that the shell of this species is often described as extremely thin (*e.g.* Macpherson, 1971).

*Recent distribution* — *Trichotropis bicarinata* is a rare species in the North Atlantic where it has been dredged at few localities, whereas it appears to be more common in the North Pacific and in the Bering Strait region (Fig. 1). The general distribution is discontinuous circumpolar, arctic/subarctic.

*Ecology* — The species has been found on various types of bottom: clay, sand, gravel and hard bottom. Its bathymetric range is from 10 m (Macpherson, 1971) to about 500 m (Posselt & Jensen, 1898).

*Fossil occurrence* — The only fossil records apart from that at Kap København that I am aware of are from the Late Pliocene and Pleistocene Gubik Formation of northern Alaska (Hopkins, 1967; L. Marinovich, pers. comm.) and from the Nome area, western Alaska (MacNeil *et al.*, 1943).

## DISCUSSION

The mollusc fauna of the Kap København Formation shows resemblance to that of the Gubik Formation in northern Alaska. Most notable is the occurrence of *Trichotropis bicarinata*, *Macoma balthica* and

*Cyrtodaria kurriana* in both formations. Together with taxa such as *Nuculana pernula*, *Portlandia* spp., *Astarte borealis*, *Serripes groenlandicus*, *Clinocardium ciliatum* and *Macoma calcarea*, these species formed part of a fauna that lived along the shores of the Arctic Ocean in the Late Neogene/Early Quaternary. These taxa, which are more or less cold adapted, appear to have a short history in the North Atlantic and northern Pacific, being mostly restricted to the Middle and Late Quaternary. It is possible that they originated in the Arctic Ocean in the Late Neogene, as a consequence of the Tertiary climatic cooling during the Tertiary which was most pronounced in the far North (e.g. Barron, 1985).

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