ON THE BIOSTRATIGRAPHICAL AGE OF THE LOWER SELANDIAN OF DENMARK

By

HANS JØRGEN HANSEN*)

Abstract

With evidence from planktonic foraminifera, it is shown that the Lower Selandian (which overlies the Danien in the type area) belongs to the *Globorotalia angulata* biozone.

Since ROSENKRANTZ (1924) proposed the preliminary stage name Selandian for the glauconitic marls and clays deposited upon the Upper Danian limestones and overlain by the Ypresian ash layers, much doubt has existed as to the stratigraphical age of the deposits.

The lithology of the Selandian sediments was described in detail by GRY (1935). The lithological development of the Selandian sediments starts with a basal conglomerate containing a large amount of redeposited Upper Danian fossils. The conglomerate is followed by glauconitic calcareous sand which displays gradually decreasing grain size upwards. These layers are followed by the Kerteminde Marl which, in its upper part becomes non-calcareous. The clay mineralogy of the Selandian sediments was described by TANK (1963) who found montmorillionite, illite and mixed-layer clay minerals in the lower greensand deposits with a dominance of montmorillionite. In the Kerteminde Marl TANK found montmorillionite and illite with the former also as the dominant mineral. Montmorillionite is more abundant in the Kerteminde Marl than in the underlying greensand.

The lower boundary of the Selandian was placed at the disconformity between the Danian limestones (the biozone characterized by *Globoconusa daubjergensis)* and the overlying glauconitic beds. The disconformity was described in detail by ROSENKRANTZ (1920 a, 1924) for the Copenhagen area and by ØDUM (1926) and GRY (1935) for Central East Jutland. A brief description of the disconformity exposed in East Fuenen was given by BERTHELSEN (1962). The disconformity provides the information that after the regression of the Danian sea, erosion took place. This locally stopped at a rather coherent flint layer, leaving the concentrated Upper Danian calcitic fossils, which are now to be found in the conglomeratic part of the overlying greensand.

The upper part of the Selandian has been dealt with by GRÖNWALL (1908) and BØGGILD (1918). GRY (1935) defined the upper boundary on pure lithological features since neither macro- nor microfossils had been found in the Upper Selandian non-calcareous clays. The non-calcareous

*) Geological Institute. University of Copenhagen.

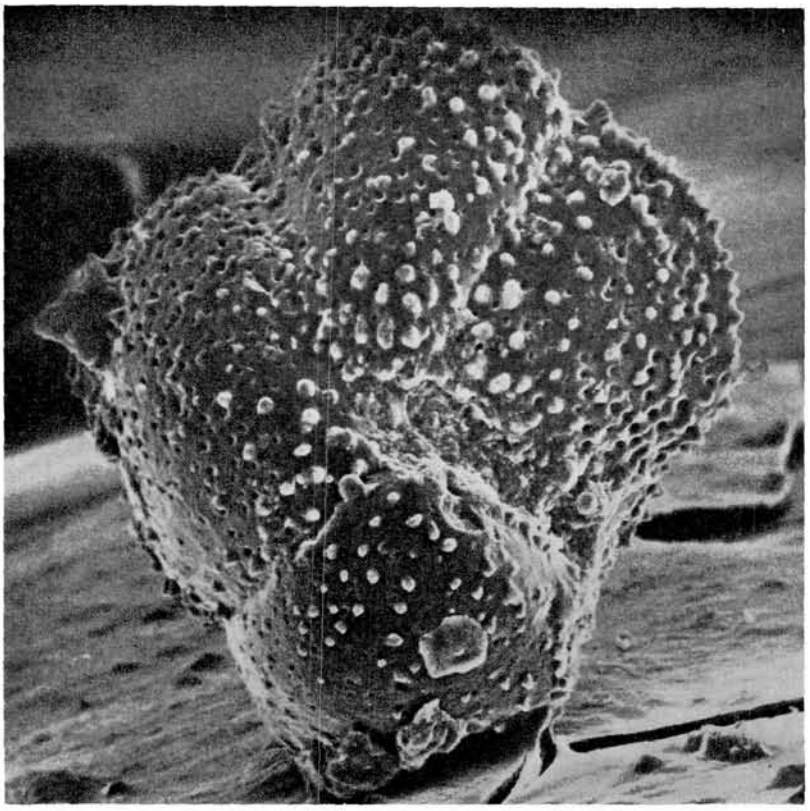

Fig. 1. *Globorotalia angulata* WHITE. Umbilical side. Locality: Vestre Gasværk, Copenhagen. Lower Selandian. Scanning electron micrograph. × 465.

clay is known from borings and from one outcrop in Central East Jutland (locality Rugaard). In samples from that outcrop the author recently found a restricted, but undoubtedly Paleocene foraminiferal fauna of the type found in the Kerteminde Marl. The superposition of the Ypresian ash layers is not found in the outcrop.

The macrofauna of the Selandian deposits of Denmark has been described by VON KOENEN (1885), GRÖNWALL (1904), GRÖNWALL and HARDER (1907), ROSENKRANTZ (1920 a, 1920 b, 1944) and RAVN (1939). The stratigraphical age of the Lower Selandian has been referred to the Montian or Thanetian. ROSENKRANTZ especially has stressed the similarity between the molluscs from Vestre Gasværk and Calcaire Grossier de Mons. As however a well-founded correlation using molluscs could not be acheived, ROSENKRANTZ proposed the preliminary stage Selandian in 1924.

The foraminiferal fauna of the Selandian has been dealt with by several authors. VON KOENEN (1885) illustrated a few larger forms from Vestre Gasværk, while FRANKE (1927) described the foraminifera and ostracoda

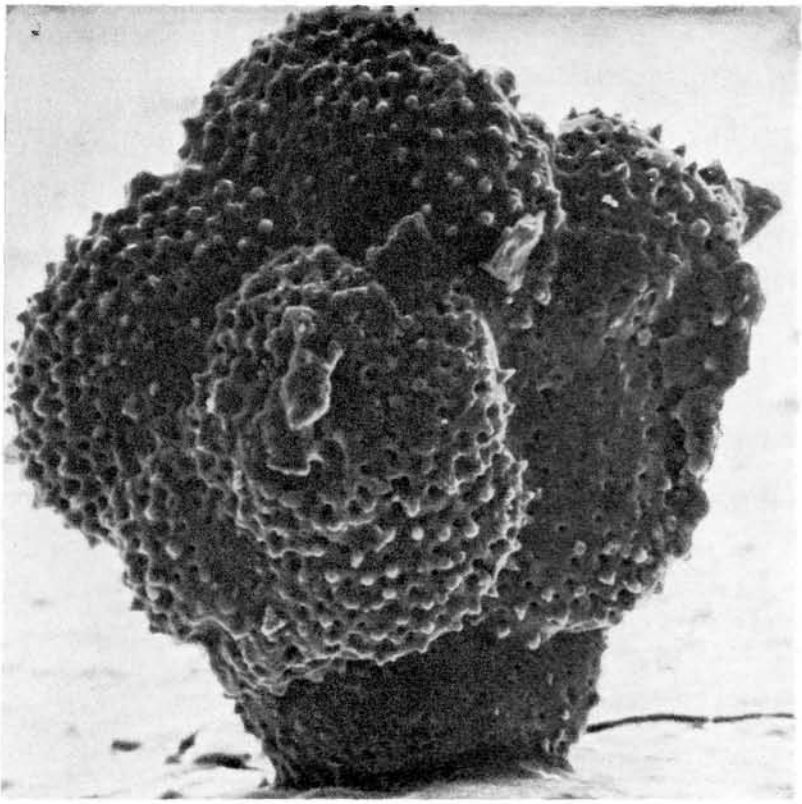

Fig. 2. *Globorotalia angulata* WHITE. Spiral side. Locality: Vestre Gasværk, Copenhagen. Lower Selandian. Scanning electron micrograph. × 465.

from the Lower Selandian of Central East Jutland and Copenhagen. BROTZEN (1948) described the Selandian foraminifera from Sweden and correlated both the Lower Selandian of Sweden and Denmark with the Wills Point Formation, the Naheola Formation of the U. S. Gulf area and the Hornerstown Formation of the U. S. east coast. The correlation was based on benthonic forms many of which are aragonitic. Since aragonitic shells in general are never found in the Danian limestones, the sudden appearence of aragonitic foraminifera in the Lower Selandian deposits would seem to be a question of preservation rather than of stratigraphical range. TROELSEN (1954), BANG (1960), BUCH (1964) and POZARYSKA (1965) all listed foraminifera from the Selandian of Denmark. HOFKER (1966) described at length the foraminifera of the Selandian. Based on benthonic forms he concluded (p. 324) that the Tuffeau de Ciply and Calcaire Grossier de Mons »are slightly younger than the Lower Selandian of Denmark, . . .«. As shown by RASMUSSEN (1965) the Tuffeau de Ciply is of Middle Danian age and is not correlatable with layers younger than the

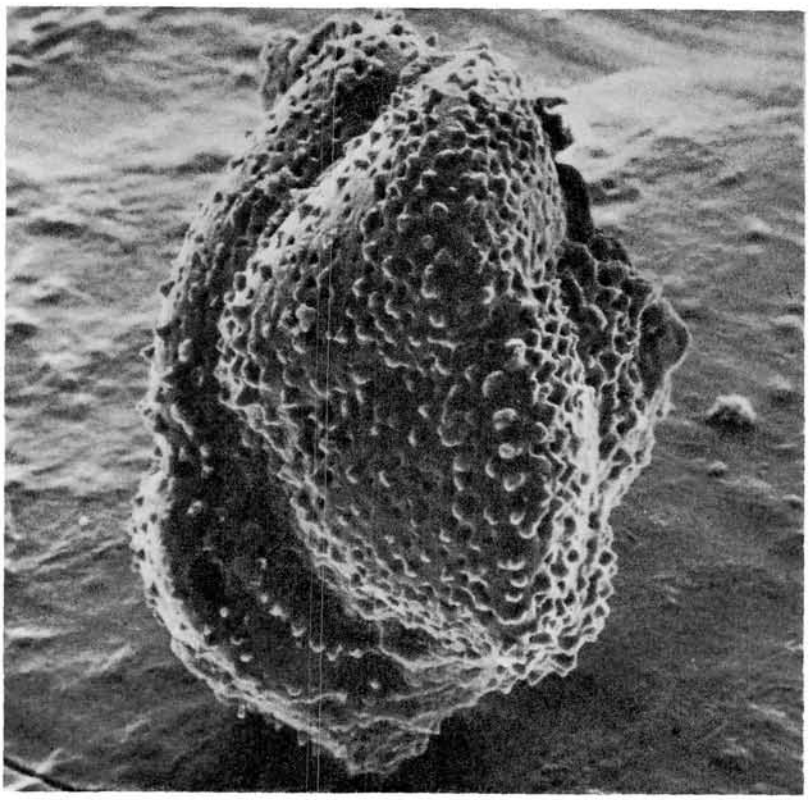

Fig. 3. *Globorotalia angulata* WHITE. Peripheral view. Locality: Vestre Gasværk, Copenhagen. Lower Selandian. Scanning electron micrograph. × 465.

Danian. As furthermore the type Montian has never been studied with respect to foraminiferal fauna, there would seem to be little reason for the correlation made by HOFKER.

The foraminiferal fauna of the dark clay at Vestre Gasværk is essentially identical to that described by BROTZEN (1948) from the Paleocene of Klagshamn. The fauna is conspicuously dominated by benthonic foraminifera. Only the planktonic species *Subbotina triloculinoides* is found but in very few numbers. Redeposited *Globoconusa daubjergensis* from the underlying Upper Danian occurs rather often, but are readily distinguished from the primary forms since they are filled in with calcareous matter and have a whitish colour.

In one of the samples from Vestre Gasværk the author has found *Globorotalia angulata* in its early form having only four chambers in the final whorl (Figs. 1–3). The biozone characterized by *G. angulata* has been correlated by EL-NAGGAR (1967) with the Heersian of Holland. The Heersian is, according to EL-NAGGAR, belonging to the same biozone as the Cal-

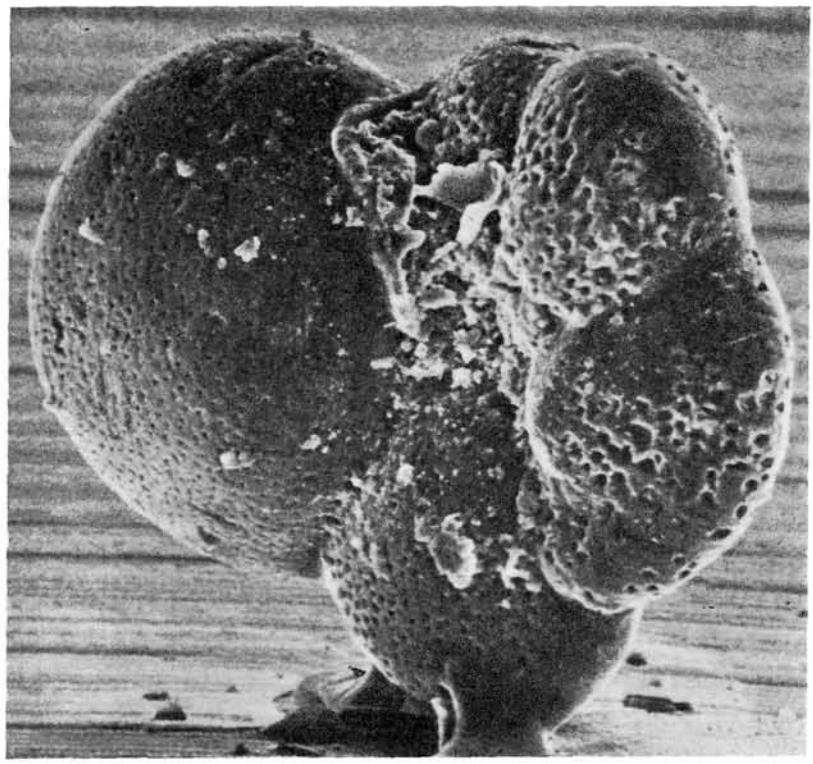

Fig. 4. *Globorotalia emilei* EL-NAGGAR.Oblique umbilical view. Locality: Kerteminde, Fyn. Selandian. Scanning electron micrograph. × 463.

caire Grossier de Mons representing the Montian stage. As however, EL-NAGGAR did not examine material from the type locality of the latter but from »lateral equivalents« it still remains an open question whether the Montian stage is a junior synonym of the Heersian stage or whether it should be correlated with the Upper Danian of Denmark as proposed by ROSENKRANTZ (1964, p. 523).

The lack of ornamented globorotaliids in the Selandian of Sweden and Denmark as well as in the Upper Paleocene from the Norwegian Basin (SAITO, BURCKLE and HORN, 1967) would indicate that there has existed a northern distributional boundary at about 55°N latitude probably due to a decline in temperature. Accordingly the diverse fauna of globorotaliids from the warmer Thethyan seas (LOEBLICH et al., 1957) is neither recorded in the Selandian of Sweden and Denmark nor in the Norwegian Basin.

The only planktonic foraminifera of the Globorotalia group, besides *G. angulata*, found in the Selandian of Denmark is *G. emilei* EL-NAGGAR (Figs. 4–6). This species has a rather long stratigraphical range and cannot be used for finer zonation.

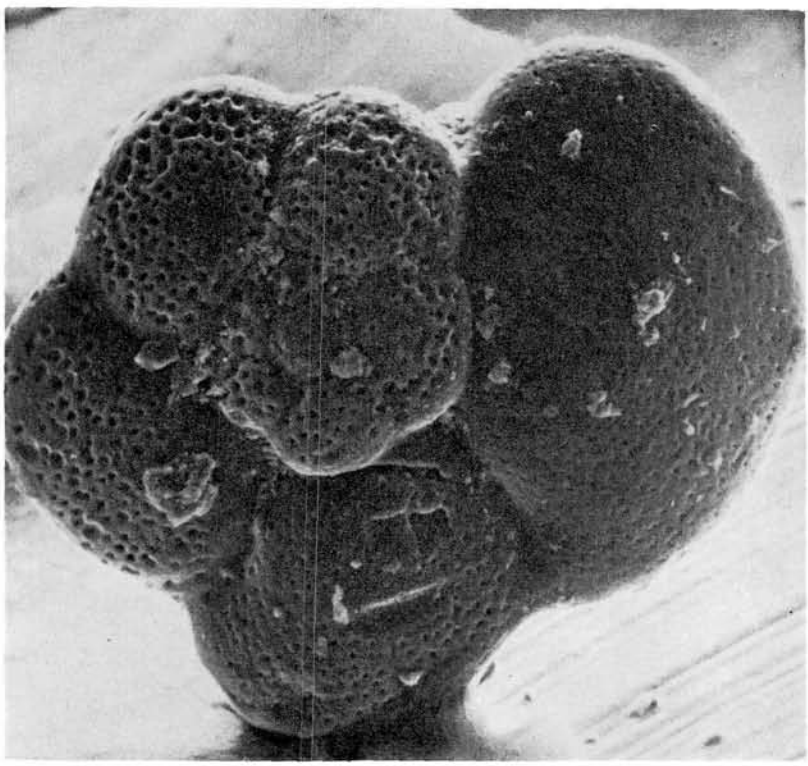

Fig. 5. *Globorotalia emilei* EL-NAGGAR. Spiral side. Locality: Kerteminde, Fyn. Selandian. Scanning electron micrograph. × 463.

The end of the Danian stage is generally accepted to be correlatable with the disappearance of *G. daubjergensis* and the appearence of *G. angulata*. This is in good agreement with the find reported here of *G. angulata* just above the Upper Danian-Selandian boundary in the type area. However, the late development stage of *G. daubjergensis* i.e. *G. kozlowskii* is found in the Lower Selandian in Jutland. Thus the boundary between the two biozones (*G. daubjergensis*-zone and *G. angulata*-zone) must be placed at the appearence of *G. angulata* and not at the extinction of the *G. daubjergensis* group.

REFERENCES

D. G. U. = Danmarks Geologiske Undersøgelse
(Danish Geological Survey).
D. G. F. = Meddelelser fra Dansk Geologisk Forening
(Danish Geological Society)

BANG, I. in RASMUSSEN, L. B. 1960: Locality Hvalløse. Int. Geol. Congress XXI. Norden 1960. Guide to excursions A 42 and C 37, part II.

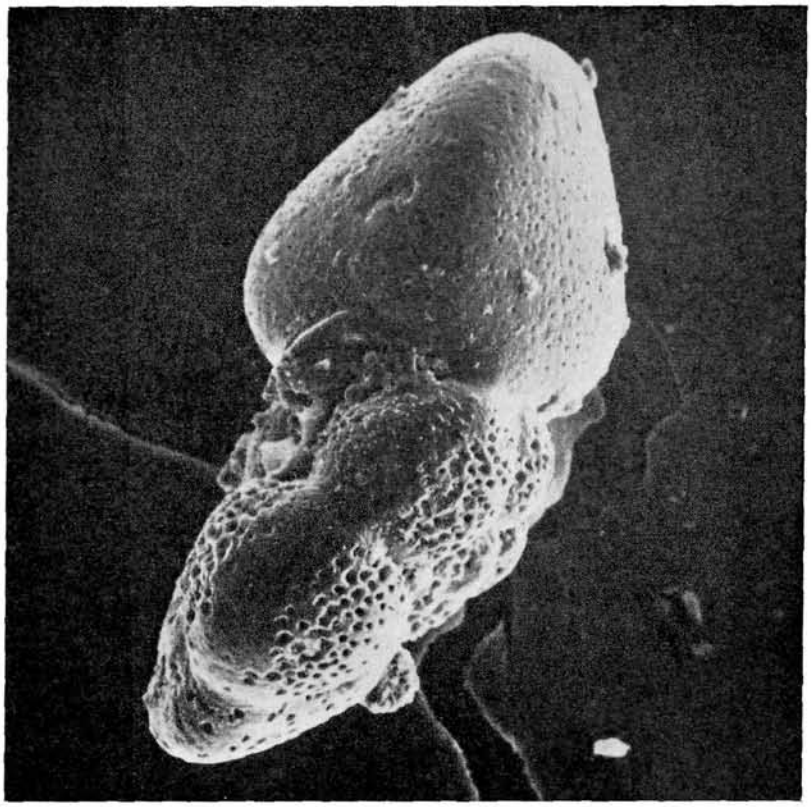

Fig. 6. *Globorotalia emilei* EL-NAGGAR. Peripheral view. Locality: Kerteminde, Fyn. Selandian. Scanning electron micrograph. × 463.

BERTHELSEN, O. 1962. Cheilostome bryozoa in the Danian deposits of East Denmark. – *D. G. U.* Ser. 2, No. 83.

BROTZEN, F. 1948. The Swedish Paleocene and its foraminiferal fauna. – *Sveriges Geol. Undersök.* Ser. C, No. 493.

BUCH, A. and SORGENFREI, T. 1964. Deep tests in Denmark 1935–1959. – *D. G. U.* Ser. 3, No. 36.

BØGGILD, O. B. 1918. Den vulkanske aske i Moleret. – *D. G. U.* Ser. 2, No. 33.

EL-NAGGAR, Z. R. 1967. On the so-called Danian s. l. or Dano-Montian of authors. – *D. G. F.* Vol. 17, pp. 103–111.

FRANKE, A. 1927. Die Foraminiferan und Ostracoden des Paleozäns von Rugaard in Jütland und Sundkrogen bei Copenhagen. – *D. G. U.* Ser. 2, No. 46.

GRY, H. 1935. Petrology of the Paleocene sedimentary rocks of Denmark. – *D. G. U.* Ser. 2, No. 61.

GRÖNWALL, K. A. 1904. Forsteningsførende blokke fra Langeland, Sydfyn og Ærø samt bemærkninger om de ældre Tertiærdannelser i det Baltiske område. – *D. G. U.* Ser. 2, No. 15.

GRÖNWALL, K. A. 1905 Nogle bemærkninger om lagfølgen ved Vestre Gasværk i København. – *D. G. F.* Vol. 2, 11.

GRÖNWALL, K. A. 1908. En boring på Samsø og nogle deraf følgende slutninger om Danmarks ældre Tertiær. – *D. G. F.* Vol. 3, pp. 133–148.

GRÖNWALL, K. A. and HARDER, P., 1907. Paleocæn ved Rugaard i Jydland. – *D. G. U.* Ser. 2, No. 18.

HARDER, P., 1922. Om grænsen mellem Saltholmskalk og Lellingegrønsand. – *D. G. U.* Ser. 2, No. 38.

HOFKER, J. J., 1966. Maastrichtian, Danian and Paleocene foraminifera. – *Palaeontographica* Suppl. Band 10.

KOENEN, A. VON, 1885. Ueber eine palaeozäne Fauna von Copenhagen. – *Abh. Königl. Gesell. Wiss. Göttingen* 32.

LOEBLICH, A. E. et al., 1957. Studies in foraminifera. – *U. S. Nat. Mus. Bull.* 215.

POZARYSKA, K., 1965. Foraminifera and biostratigraphy of the Danian and Montian in Poland. – *Palaeont. Polon.* 14.

RASMUSSEN, H. W., 1965. The Danian affinities of the Tuffeau de Ciply in Belgium and the »Post-Maastrichtian« in the Netherlands. – *Medd. Geol. Sticht.* N. S. 17.

RAVN, J. P. J., 1939. Études sur les Mollusques du Paleocene de Copenhague. – *Det Kgl. Dan. Vid. Selsk. Biol. Skr.* 1,1.

ROSENKRANTZ, A., 1920a. Craniakalk fra Københavns Sydhavn. – *D. G. U.* Ser. 2, No. 36.

ROSENKRANTZ, A., 1920b. En ny Københavnsk lokalitet for forsteningsførende Paleocæn. – *D. G. F.* Vol. 5,20.

ROSENKRANTZ, A., 1924. De Københavnske grønsandslag og deres placering i den Danske lagrække. – *D. G. F.* Vol. 6,23.

ROSENKRANTZ, A., 1930. Den Paleocæne lagserie ved Vestre Gasværk. – *D. G. F.* Vol. 7.

ROSENKRANTZ, A., 1944. Oversigt over Nautilerne i vort yngste Senon, Danien of Paleocæn. – *D. G. F.* Vol. 10.

ROSENKRANTZ, A., 1964. Note on some Cranias from Central Poland. – *Acta Palaeont. Polonica.* 9,4.

SAITO, T., BURCKLE, L. H. and HORN, D. R., 1967. Paleocene core from the Norwegian Basin. – *Nature* Vol. 216, pp. 357–359.

TANK, R. W., 1963. Clay mineralogy of some Lower Tertiary (Paleogene) sediments from Denmark. – *D. G. U.* Ser. 4, Vol. 4, No. 9.

TROELSEN, J. C., 1954. Paleocæn nord for Mariager fjord. – *D. G. F.* Vol. 12, pp. 479–480.

ØDUM, H., 1926. Studier over Daniet i Jylland og på Fyn. – *D. G. U.* Ser. 2, No. 45.