

## Marine Interglacial Deposits in the Cuxhaven Area, NW Germany: A Comparison of Holsteinian, Eemian and Holocene Foraminiferal Faunas

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Holsteinian, Eemian, Holocene, core, biostratigraphy, foraminifers  
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**Abstract:** Interglacial foraminiferal faunas are described from Holsteinian, Eemian, and Holocene deposits in borings from the Cuxhaven area. These assemblages are compared with published faunal lists from corresponding interglacial deposits in NW Germany and Denmark.

The faunal succession of each interglacial sequence in the present area has its own characteristic features. Of particular interest is the fact that the presence and/or abundance of certain taxa in each of the interglacials may prove to be useful for correlation purposes in the southern North Sea area.

[Marine Interglazialablagerungen aus dem Raum Cuxhaven, NW-Deutschland: Ein Vergleich der Foraminiferen-Faunen von Holstein, Eem und Holozän]

**Kurzfassung:** Es werden interglaziale Foraminiferen-Faunen aus dem Holstein, dem Eem und dem Holozän für den Raum Cuxhaven beschrieben. Bei den bearbeiteten Proben handelt es sich um Material aus Kernbohrungen. Die Vergesellschaftungen werden mit vorliegenden Publikationen entsprechender Vorkommen aus Nordwestdeutschland und Dänemark verglichen.

Jede der 3 untersuchten Faunen hat typische Züge. Von besonderem Interesse ist die Tatsache, daß die Anwesenheit und/oder Häufigkeit bestimmter Taxa für das Gebiet der südlichen Nordsee stratigraphische Korrelationen ermöglicht.

### 1. Introduction

This paper describes and compares the foraminiferal faunas of marine Holsteinian, Eemian, and Holocene deposits in the Cuxhaven area, NW Germany. Results of the Holsteinian of the Neuwerk borings (figs. 1 and 2) have already been published (KNUDSEN 1988a).

The Holocene material examined here derives from the same Neuwerk borings, while the Eemian foraminifera have been collected from a boring nearby at

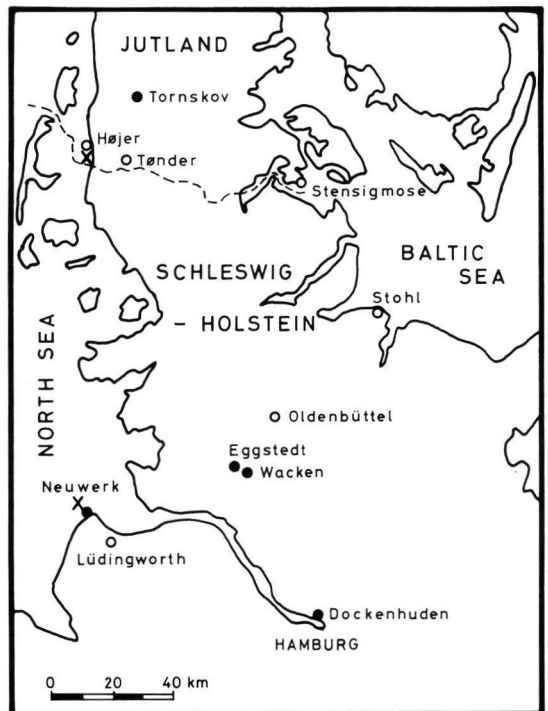


Fig. 1: Localities referred to in the text in NW Germany and S. Denmark. Filled rings = Holsteinian sites; open rings = Eemian sites; cross = Holocene sites.

Abb. 1: Lokalitäten in NW-Deutschland und S-Dänemark, die im Text näher erläutert sind.

Ausgefüllte Kreise = Holstein; offene Kreise = Eem; Kreuz = Holozän.

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Lüdingworth (figs. 1 and 2). The latter boring was made by G. LINKE, Hamburg in 1981. The juxtaposition of these boreholes allows us to compare the faunal compositions of the three interglacial periods from a limited geographic region.

The interglacial faunas from the Cuxhaven area are also compared with some of the earlier records from Holsteinian, Eemian, and Holocene deposits in NW Germany and adjacent areas. Holsteinian assemblages from this region have previously been described by i. a. BUCH (1955), WOSZIDLO (1962), WIEGANK (1972), and KNUDSEN (1980, 1987a, 1987b, 1988a, 1988b, 1988c), while Eemian foraminiferal faunas have been examined by i. a. VAN VOORTHUYSEN (1957), LAFREZ (1963), KONRADI (1973), and KNUDSEN (1985). Foraminiferal faunas from Holocene deposits in borings of the southern North Sea were previously investigated by SØRENSEN (1980) und UFFENORDE (1982). Comparable Recent faunas were described by i. a. VAN VOORTHUYSEN (1960), HAAKE (1962), and RICHTER (1964a, 1964b, 1967).

The samples examined in the present study have been treated according to the laboratory methods described by MELDGAARD & KNUDSEN (1979) and KNUDSEN

(1988b). The percentage frequencies of the most common foraminiferal species are shown in range charts (figs. 4 and 7). Assemblage zones have been established in accordance with the definition given by HEDBERG (1976).

## 2. The Lüdingworth boring

The Lüdingworth boring is located about 10 km SE of Cuxhaven; TK 25 Westerwanna, R = 34,84460, H = 59,61030 (figs. 1 and 2). The level at the bore site is less than 1 m above present day sea-level. Marine interglacial sandy silts were found between 19.00 and 14.50 m depth in the borehole. Glacigenic sediments occurred both below and above the interglacial deposits, while the top of the sequence consisted of a Holocene peat overlain by marine sands, silts, and clays. The marine Holocene sequence has not been examined in the present study. A lithological description of the Lüdingworth boring, made by G. LINKE, is shown in fig. 3.

The stratigraphical position of the marine Eemian sequence at Lüdingworth is shown in fig. 8. HÖFLE et al. (1985, fig. 1) demonstrated, however, that

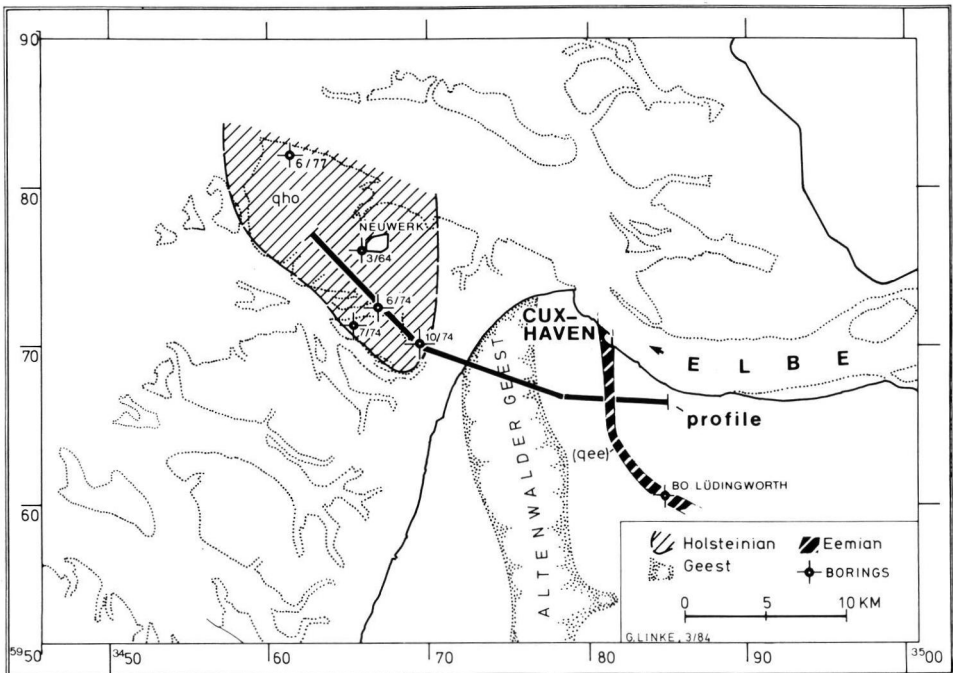
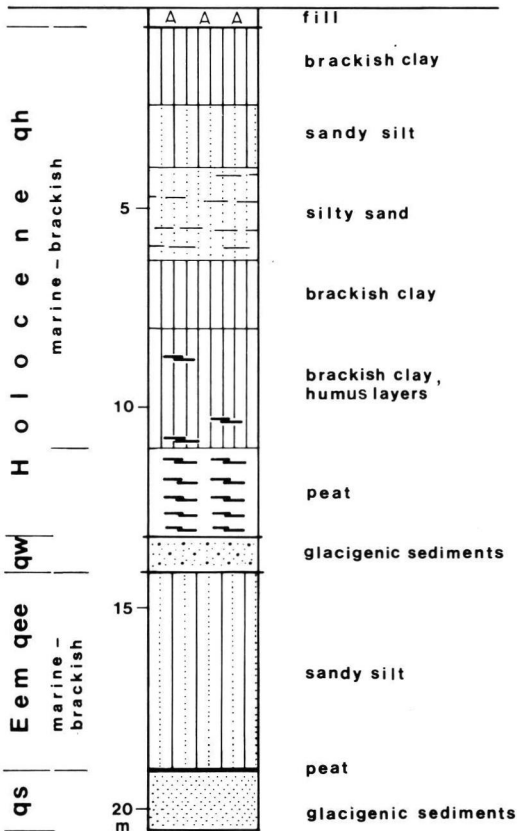


Fig. 2: Studied borings at Lüdingworth and in the Neuwerk area.

The areal extent of the marine Holsteinian and Eemian deposits are indicated (according to G. LINKE 1984). Dotted line indicates the extent of the present tidal flats.

Abb. 2: Untersuchte Bohrungen im Gebiet von Lüdingworth und Neuwerk. Die Verbreitung des marinen Eem und Holstein sind angegeben (Angaben nach G. LINKE 1984). Die punktierte Linie bezeichnet die heutige Gezeitengrenze.

## BO. LÜDINGWORTH



G. LINKE, 3/84

Fig. 3: Lithology of the Quaternary sequence in the Lüdingworth boring. qs = Saalian; qw = Weichselian (G. LINKE 1984).

Abb. 3: Lithologie der quartären Schichtenfolge in der Bohrung Lüdingworth. qs = Saale; qw = Weichsel (G. LINKE 1984).

marine conditions extended over a much larger area around Cuxhaven during the Eemian Interglacial than is indicated here.

### 2.1. Foraminiferal zonation and palaeoenvironment

The marine interglacial sequence has been subdivided into 3 foraminiferal assemblage zones, zones L1 to L3. The relative frequencies of the most common taxa in each sample is shown in the range chart, fig. 4.

Only one sample (18.75–19.00 m depth) is included in the lowermost zone L1. *Elphidium albumbilicatum* is the dominant species, and *Nonion orbiculare*, *Buccella frigida*, *Elphidium incertum*, *E. williamsoni*,

and *Nonion germanicum* also occur. The sediment is rich in plant debris, and the foraminiferal tests are partly secondarily dissolved, probably by acidic ground water. The high frequency of *E. albumbilicatum* in zone L1 points to an initial stage of a marine transgression (see also PENNEY 1985, fig. 3). According to LUTZE (1965) this species can tolerate extremely low salinities. Most of the species in zone L1 are the same as found in intertidal areas of the boreal faunal province today (i. a. VAN VOORTHUYSEN 1960; HAAKE 1962).

Assemblage zone L2 covers the interval from 18.75 to 16.50 m. The sharp rise in *Elphidium incertum* and *Buccella frigida* indicates a rapid change to deeper, sublittoral conditions and higher salinities. Other characteristic faunal elements include *Elphidium williamsoni*, *Nonion niveum*, and *N. orbiculare*. *E. albumbilicatum* still occurs, together with low frequencies of *Ammonia batavus*. These faunas indicate temperate climatic conditions. The water depth may have been as much as 10–20 m. The rise in *Ammonia batavus* at the top of the zone L2 is an indication of a return to shallower, intertidal conditions.

*Ammonia batavus* dominates zone L3, but *Nonion germanicum* and *Elphidium albumbilicatum* are still common species. This faunal composition, together with the marked rise in *Elphidium gunteri*, indicates extremely shallow water and reduced salinities (see also UFFENORDE 1982).

The complete Eemian marine transgression is, thus, preserved at Lüdingworth. Marine conditions were first established above a peat horizon at about 19 m depth (zone L1). The environment was initially brackish and shallow, but was rapidly superseded by a period with more saline, sublittoral conditions (zone L2). The final stage (zone L3) records a return to shallow, brackish waters consequent on a fall in sea-level.

### 2.2. Correlation and age

The foraminiferal faunas of the interglacial Lüdingworth sequence are comparable with those described from the Eemian of NW Germany (LAFRENZ 1963; KNUDSEN 1985; KUBISCH & SCHÖNFELD 1985) and adjacent areas in the Netherlands (VAN VOORTHUYSEN 1957), Denmark (KONRADI 1976; SØRENSEN 1980), GDR (WIEGANK 1972), and Poland (BRODNIOWICZ 1972).

Common to the Eemian faunas in the above-mentioned studies is the presence of *Nonion niveum*. This species is especially characteristic for Eemian faunas in the eastern part of the region, i. e. from the Oldenbüttele area and eastwards to the areas around the Baltic Sea (see also KNUDSEN 1985). The two lusitanian



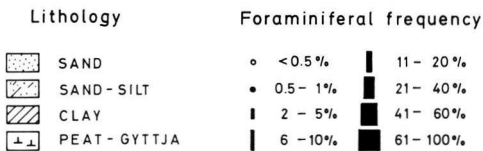


Fig. 5: Legend for the lithology and foraminiferal frequencies, fig. 4 and 7.

Abb. 5: Legende: Lithologie und Häufigkeit der Foraminiferen, Fig. 4 und 7.

### 3.1. The Holsteinian of Neuwerk 6/74

The marine sequence between 29.0 and 45.2 m depth in this boring has been referred to the Holsteinian Interglacial on the basis of both pollen and foraminifera (LINKE et al. 1985; KNUDSEN 1988a).

The faunal compositions in the assemblage zones EA, EW, and EN indicate a gradual change from a very shallow, intertidal habitat in the lower zone to slightly deeper, more open conditions in the top zone (see also KNUDSEN 1988a). Of a special interest is the co-occurrence of arctic taxa, such as *Elphidium ballandense* and *Nonion orbiculare*, with the lusitanian *Aubignyna perlucida*. Pollen analyses of the Holsteinian deposits from the Neuwerk area show that these marine sediments were deposited during the pollen zone 3 after LINKE & HALLIK (prel. comm. 1986, Inqua-Symposium: Holstein-Interglazial, Hamburg). This corresponds the pollen zone 3 of ERD (1973) and pollen zones VII/VIII of MÜLLER (1974).

The Holsteinian foraminiferal faunas correspond to those found in similar deposits in the adjacent areas of NW Germany, and especially those that indicate relatively direct access to normal marine North Sea waters in Schleswig-Holstein and at Hamburg (KNUDSEN 1988b).

### 3.2. The Holocene of Neuwerk 6/77

The marine Holsteinian deposits at Neuwerk are typically overlain by a 5–10 m thick sequence of glacial sediments (fig. 8), which are considered Saalian in age (LINKE 1970). This unit is overlain by marine Holocene silts and sands, at some places with a basal peat at the bottom. Holocene sediments here have a maximum thickness of about 25 m.

The marine Holocene of boring 6/77 is subdivided into two foraminiferal zones, zones H1 and H2. Each sample in this sequence spans an interval of 1 m of sediment.

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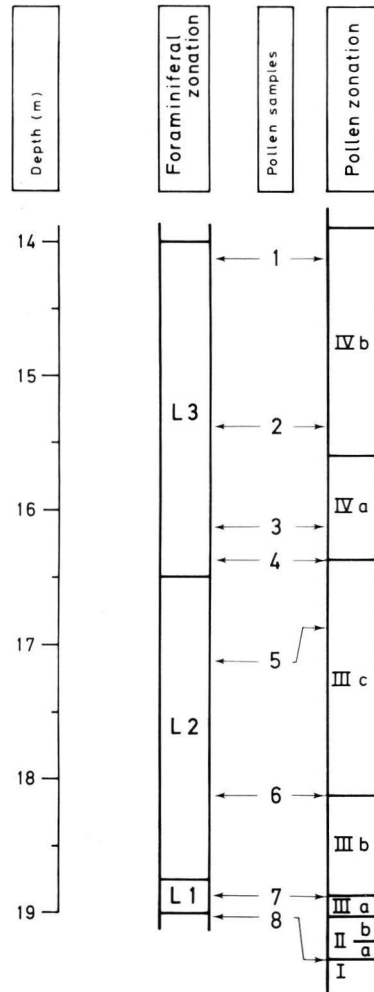


Fig. 6: Correlation of the Eemian foraminiferal zones at Lüdingworth with the Eemian pollen zonation of MÜLLER (1974).

Abb. 6: Korrelation der Eem-Foraminiferen-Zonen bei Lüdingworth mit den Pollen-Zonen nach MÜLLER (1974).

Zone H1 is dominated by *Ammonia batavus* and *Elphidium williamsoni*, but *Nonion germanicum*, *N. depressulum*, *Elphidium excavatum* forma *selseyensis* (see FEYLING-HANSEN 1972), *E. gunteri*, and *E. magellanicum* are also common species. The relative importance of *Elphidium gunteri*, together with low numbers of *E. albiumbilicatum* points to the presence of a shallow, brackish intertidal environment at the base of the sequence. The zone H1 fauna may, however, well represent two different types of environment. This is indicated by the occurrence of low





specimen numbers towards the top of the Holocene may be an indication of relatively higher accumulation rates here. No secondary etching of foraminiferal tests is observed.

#### 4. Comparison of the interglacial foraminiferal faunas

A comparison of the Holsteinian and Holocene species composition in fig. 7 shows that the two are almost equal. Certain different characteristics do, however, occur, which may be useful for correlation purposes. One of these is the presence of certain arctic taxa in the Holsteinian deposits at Neuwerk. Arctic species are especially common in the early part of the Holsteinian Interglacial in both NW Germany and SW Denmark. They have, for example, been recorded in the Holsteinian of Eggstedt and Dockenhuden (KNUDSEN 1988b), at Wacken (KNUDSEN 1988c), and at the base of the Holsteinian at Tornskov (KNUDSEN 1987b). The co-occurrence of *Buccella frigida* and *Nonion orbiculare* can also be considered a characteristic feature throughout the marine Holsteinian of NW Germany and SW Denmark.

Another typical feature of the Holsteinian faunas in the southern North Sea area is the presence of the lusitanian species *Aubignyna perlucida* (see also KNUDSEN 1980, 1987b). This species occurs only sporadically both in the Holocene and in the Eemian Interglacial deposits in this region. It is normally much more common in the Holsteinian than was the case in the Neuwerk boring (fig. 7).

Eemian Interglacial faunas can be distinguished from the Holsteinian and Holocene faunas by the co-oc-

urrence of *Buccella frigida*, *Nonion orbiculare*, and *Nonion niveum*. These taxa are, for example, present in Eemian deposits at Lüdingworth (fig. 4), and they have been recorded at many other Eemian sites in the southern North Sea region, e. g. at Oldenbüttel (KNUDSEN 1985) and Stohl (KUBISCH & SCHÖNFELD 1985) in Schleswig-Holstein and at Tønder (SØRENSEN 1980) and Stensigmosse (KONRADI 1976) in Denmark.

*Elphidium translucens* and *E. lidoense* are also very typically present in Eemian shallow water deposits in NW Germany and S. Denmark (e. g. LAFRENTZ 1963; KNUDSEN 1985; KONRADI 1976; SØRENSEN 1980), although they are rare or absent at Lüdingworth (fig. 4).

*Quinqueloculina padana*, another lusitanian species, is a characteristic element of deeper water Eemian deposits of N. Jutland, Denmark (KNUDSEN & LYKKE-ANDERSEN 1982; KNUDSEN 1984). This species is not found in Eemian intertidal deposits. Shallow subtidal and intertidal Eemian sediments may, however, be characterized by the presence of other lusitanian taxa, such as *Quinqueloculina aspera* and *Q. seminulum* var. *jugosa*. Both species requires normal marine salinities, and they have, for instance, been recorded in Eemian faunas along the North Sea coasts of the Netherlands (VAN VOORTHUYSEN 1957) and Denmark (SØRENSEN 1980). The latter taxa was also found in the Eemian of the western part of Schleswig-Holstein (LAFRENTZ 1963).

It is, therefore, normally possible to distinguish Eemian Interglacial faunas from other interglacial assemblages by their warmer water aspect. For unknown reasons lusitanian species are almost absent in the Eemian assemblages at Lüdingworth (fig. 4).

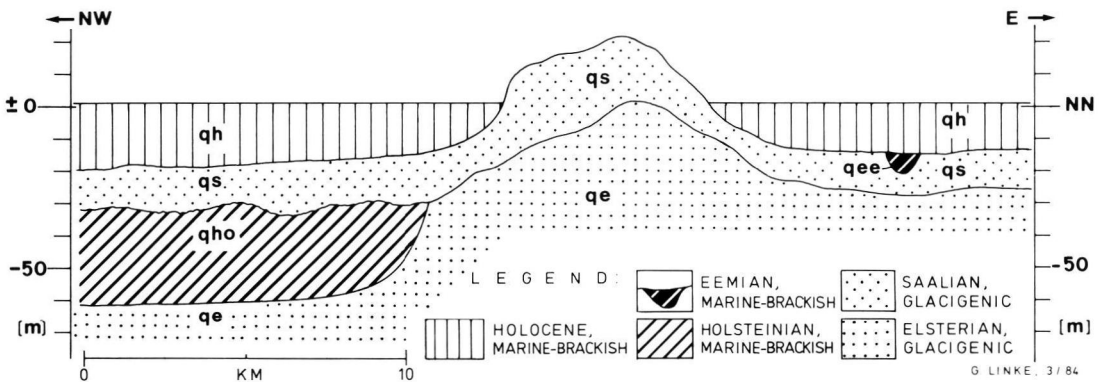


Fig. 8: Cross section through the Quaternary deposits from the Neuwerk area to the Lüdingworth area (G. LINKE 1984). Profile line is shown in fig. 2. (qh = Holocene; qee = Eemian; qs = Saalian; qho = Holsteinian; qe = Elsterian).

Abb. 8: Geologischer Schnitt durch Quartärlagerungen im Gebiet von Neuwerk bis Lüdingworth (G. LINKE 1984). Die Profilinie ist in Fig. 2 angegeben. (qh = Holozän; qee = Eem; qs = Saale; qho = Holstein; qe = Elster).

## 5. Foraminifera

The species mentioned in the text are arranged alphabetically in the following list. Only the most common occurring species and those which have been significant for the interpretation are mentioned here.

*Ammonia batavus* (HOFKER 1951)  
*Angulogerina angulosa* (WILLIAMSON 1858)  
*Aubignyna perlucida* (HERON-ALLEN & EARLAND 1913)  
*Bolivina pseudoplicata* HERON-ALLEN & EARLAND 1930  
*Buccella frigida* (CUSHMAN 1922)  
*Cassidulina reniforme* NØRVANG 1945  
*Cibicides lobatulus* (WALKER & JACOB 1798)  
*Elphidium albiumbilicatum* (WEISS 1954)  
*Elphidium excavatum* (TERQUEM) forma *selseyensis* (HERON-ALLEN & EARLAND 1911)  
*Elphidium gerthi* VAN VOORTHUYSEN 1957  
*Elphidium gunteri* COLE 1931  
*Elphidium hallandense* BROTZEN 1943  
*Elphidium incertum* (WILLIAMSON 1858)  
*Elphidium lidoense* CUSHMAN 1936  
*Elphidium macellum* (FICHEL & MOLL 1798)  
*Elphidium magellanicum* HERON-ALLEN & EARLAND 1932  
*Elphidium margaritaceum* CUSHMAN 1930  
*Elphidium translucens* NATLAND 1938  
*Elphidium voorthuyseni* HAAKE 1962  
*Elphidium williamsoni* HAYNES 1973  
*Fissurina laevigata* REUSS 1850  
*Nonion depressulum* (WALKER & JACOB 1798)  
*Nonion germanicum* (EHRENBERG 1940)  
*Nonion niveum* LAFRENZ 1963  
*Nonion orbiculare* (BRADY 1881)  
*Quinqueloculina aspera* D'ORBIGNY 1826  
*Quinqueloculina padana* PERCONIG 1954  
*Quinqueloculina seminulum* (LINNÉ 1758)  
*Quinqueloculina seminulum* var. *jugosa* CUSHMAN 1944

## 6. Acknowledgements

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