# *Fragilaria intermedia* (Grunow) Grunow in Van Heurck, the correct name for *Fragilaria neointermedia* Tuji & D.M.Williams (*Fragilariaceae, Bacillariophyta*)

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In 1862, Grunow described *Fragilaria mutabilis* var. β *intermedia* in his monograph on the diatoms of Austria (Grunow, 1862: 369, pl. IV (erroneously written as VII), fig. 9). A short description was added: "*Streifen 27—30 in 0.001". Schalen meist mit zugespitzten Enden. Streifen oft in der Mitte fehlend"*. The taxon was one of the four varieties Grunow described under *Fragilaria mutabilis*, the other three being "var. α *genuina*" Grunow, *nom. inval.* (Turland & al. 2018, Art. 24.3), var. γ *diatomacea* Grunow and var. δ *subsolitaris* Grunow. Grunow transferred the nominate species, *Odontidium mutabile* W.Smith (1853: 290), to the genus *Fragilaria* based on its ribbon-like colonies, for him a key feature of this genus [*Frustula rectangula in fascias longiores vel catenas solutas conjuncta, valvis symmetricis costis inullis* (Grunow 1862: p. 365)]. Nowadays, scanning electron microscopy analysis has shown that, as far as we know, all *Fragilaria* taxa that form ribbon-like colonies use interlocking linking spines, an observation not possible in Grunow's time. Typical examples include *F. mesolepta* Rabenhorst (Heudre & al. 2019) and *F. rumpens* (Kützing) C.W.F.Carlson (Van de Vijver & al. 2022), both having well-developed linking spines. Although colony-formation as such may not be a critical morphological feature, the presence of these linking spines is a critical character and given their presence in all colony-forming *Fragilaria* taxa, it is very likely that *Fragilaria mutabilis* var. β *intermedia* also possesses these spines.

Grunow (1862, pl. IV: fig. 9) illustrated only one of the four varieties, var. *intermedia* (Fig. 1), showing two valves in valve face view (a & c) and four frustules linked together to form a short ribbon-like colony (b). Several years later, Van Heurck (1881, pl. XLV: figs 9–11) raised the variety *intermedia* to species level as *Fragilaria* (*Staurosira*) *intermedia* Grunow and illustrated the species with six drawings taken from several different gatherings.

An annotated copy of Van Heurck's Atlas of the *Synopsis des Diatomées de Belgique* is conserved in the Grunow collection at the herbarium of the Naturhistorisches Museum (**W**) in Vienna, Austria. Next to the illustrations in this copy of Van Heurck (1881) for *Synedra* and *Fragilaria*, Grunow added hand-written notes indicating which sample was used to make the drawings. This information allows one to conclude that the drawings of *Fragilaria intermedia* in Van Heurck (1881, pl. XLV: figs 9–11) were made based on three samples, and not two as stated in Tuji & Williams (2013: 7) (Fig. 2). Figure 9 was taken from a sample collected in Ormesby and is most likely based on sample Walker Arnott 914/915 that was gathered by Frederic Kitton (1827–1895) from Ormesby Broad, a lake close to the city of Norwich (Norfolk, UK). Van Heurck (1896: 326) had added the latter information in his discussion of the taxon *Fragilaria tenuicollis* var. *intermedia* (Grunow) Van Heurck, as he considered the species *F. intermedia* to be a variety of *F. tenuicollis* Heiberg. Figure 10 is based on Grunow sample 31 (Neustädter Canal near Vienna, 02.III.1856, leg. A. Grunow) and the four drawings of figure 11 were all taken from Grunow sample 552 (Stienitz See near Berlin, Germany). More information on the Grunow samples can be found in Grunow's accession books (also conserved at **W**), cataloguing Grunow's entire sample collection. For both samples 31 and 552, Grunow listed *F. intermedia* m. [*mihi*] as being present in the sample (Figs 3, 4). Hustedt (1931: 125, fig. 666) discussed and illustrated *F. intermedia* adding two Grunow taxa (*Synedra vaucheriae* var. *distans* Grunow and *S. vaucheriae* var. *deformis* Grunow) as synonyms. His drawings and description clearly represent a taxon forming ribbon-like colonies (*zu dicht geschlossenen Bändern verbunden*). Several years later, Petersen (1938) analysed the type material

of *Exilaria vaucheriae* Kützing and slide 314 of Van Heurck's exsiccata set *Types du Synopsis des Diatomées de Belgique* representing a population of *Fragilaria intermedia* in a sample from Holstein. He concluded that the two species were identical (Petersen 1938: 166) and that the correct name to be used for this taxon should be *Fragilaria vaucheriae* (Kützing) J.B.Petersen. Lange-Bertalot (1980: 728–729) continued the discussion but maintained the conspecificity of *F. intermedia* and *F. vaucheriae*, even though the latter never produces ribbon-like colonies.

In 2013, Tuji & Williams reanalysed the original material of *Fragilaria intermedia* and *Exilaria vaucheriae* together with the types of *S. vaucheriae* var. *distans* and var. *deformis*. They designated Grunow sample 552 as lectotype for *Fragilaria intermedia* and described the valves in Grunow sample 31 as a new species, *F. neointermedia* Tuji & D.M.Williams separating the *F. intermedia* drawings 9 & 10 on pl. XLV (Van Heurck 1881) from *F intermedia sensu stricto* (pl. XLV: fig. 11). They also confirmed the conspecificity of *F. intermedia* with *F. vaucheriae* as suggested by Pedersen (1938).

The material for Grunow samples 31 and 552 was retrieved from the Grunow collection in Vienna (**W**) whereas the material for Walker Arnott sample 915 was found in the Van Heurck collection at Meise Botanic Garden (**BR**). After preparation of small amounts of these three samples, the resulting slides were observed using light microscopy.

Analysis of the valves in sample 552 revealed the presence of at least three different taxa (Figs 4–35), all showing some resemblance to the type material of *Fragilaria* (*Exilaria*) *vaucheriae*. All three taxa, however, possess only specimens not producing ribbon-like colonies. Only single valves were observed, and almost all photographed valves are in clear focus. Sample 31, however, contains a large population of a ribbon-like colony-forming taxon, possessing a large resemblance to the original drawings Grunow produced in 1862 (Figs 36–48). Although prepared identically as sample 552, long, ribbon-like colonies could be observed, often linking more than six frustules together (Fig. 36). Moreover, none of the photographed valves could be observed in clear focus, indicating that even in valve face view, two valves were tightly connected to each other with the valve exteriors linked. Figure 37 represents two valves in girdle view showing this tight linking.

The Ormesby sample (Walker Arnott 914/915) was not analysed in Tuji & Williams (2013). Analysis of this slide showed that at least two *Fragilaria* taxa were present in the sample, resembling the drawings in Van Heurck (1881, pl. XLV: figs 9–11): one showing ribbon-like colonies, identical to the drawings Grunow published in 1862 (Figs 49–58) and one, identified by Walker Arnott in his hand-written catalogue (kept in **BR**) as *Fragilaria tenuicollis* Heiberg, the latter not producing band-like colonies (Figs 59–69). Both taxa not only differ in the presence of the ribbon-like colonies, but also in the shape of the apices (*F. tenuicollis* having capitate and the other taxon more rostrate apices) and their stria density with *F. tenuicollis* having a lower density). The drawing in Van Heurck (1881, pl. XLV: fig. 9) represents the *F. tenuicollis* valve, indicated in pencil by Grunow next to the drawing and not *F. intermedia*. Unfortunately, although the type slide of *F. tenuicollis* (kept in **BR**, IX-20-C8) has been thoroughly scanned, no valves showing some resemblance to the valves depicted by Heiberg (1863: pl. V: fig. XIII) could be found. As original material is no longer available (N. Lundholm & C. Lang, Natural History Museum of Denmark, pers. comm.), the identity of this species remains unclear. The valves found in Walker Arnott sample 914/915 also differ from the original *F. tenuicollis* valves, making the identification by Walker Arnott and later Grunow doubtful. The taxon is currently intended to be described as a new species (Van de Vijver & Williams, unpubl.).

By selecting sample 552 as lectotype for *F. intermedia*, Tuji & Williams (2013) contradicted the original identity of the species as described and illustrated by Grunow (1862) forming ribbon-like colonies. On the other hand, the valves now included in *F. neointermedia* (Grunow sample 31) correspond entirely with the original description of *F. intermedia* as Grunow conceived it. The

confusion most likely arose from the comment Grunow added in 1862 (p. 369) that he observed a population in the Stienitz See near Berlin (sample 552), although he also wrote that the var. *intermedia* was very often found together with the var. *genuina*, which was observed in several lakes and slowly flowing waters such as the Neustädter Canal, the sampling locality of sample 31.

Given the above-mentioned evidence, the correct name for *Fragilaria neointermedia* is:

*Fragilaria intermedia* (Grunow) Grunow in Van Heurck, Synopsis des Diatomées de Belgique, Atlas, expl. pl. XLV: figs 9-11, 1881.

≡ *Fragilaria mutabilis* var. β *intermedia* Grunow in *Verhandlungen der kaiserlich-königlichen zoologisch-botanischen Gesellschaft in Wien 12:* 369, pl. IV: fig. 9, 1862.

≡ *Fragilaria neointermedia* Tuji & D.M.Williams in *Bulletin of the National Museum of Natural Science, series B, Botany* 39(1): 7, figs 28-42, *nom. illeg.* (Art. 52.2).

Lectotype (designated here, superseding lectotype by Tuji & Williams 2013): **W** slide 31 mounted with Styrax in Grunow collection made from Grunow sample 31.

Notes: According to Art. 9.19, a lectotype must be followed and "may only be superseded by a non-conflicting element of the original material" if it "is in serious conflict with the protologue" (Turland & al. 2018: 25). As Grunow (1862: pl. IV: fig. 9 b) in his protologue explicitly documented a ribbon-like colony, this is a main character of the described *Fragilaria intermedia*. Thus, a lectotypification among the gatherings cited in Grunow (1862), should select valves that are ribbon-forming. Otherwise, the lectotypification is in serious conflict to the protologue. Tuji & Williams (2013) lectotypified a non-ribbon-forming specimen for *Fragilaria intermedia* but selected a ribbon-forming specimen among the original materials of *Fragilaria intermedia* as holotype of the newly described *Fragilaria neointermedia* which corresponds entirely with the protologue of the former. Thus, we treat *Fragilaria neointermedia* as a superfluous name for *Fragilaria intermedia* in the original sense of Grunow (1862). We agree with Pedersen (1938), Lange-Bertalot (1980), and Krammer & Lange-Bertalot (2004) that Grunow in Van Heurck (1881) documented also *Fragilaria vaucheriae* but these misidentifications are *Fragilaria intermedia sensu post auctorum* and not part of the protologue.

The authors wish to thank Dr Tanja M. Schuster, curator of the Kryptogams collection of the Naturhistorisches Museum in Vienna (**W**) for helping us with the scans of the annotated Van Heurck Atlas and Grunow's annotation books. Dr David M. Williams is thanked for his constructive comments that greatly improved this manuscript.

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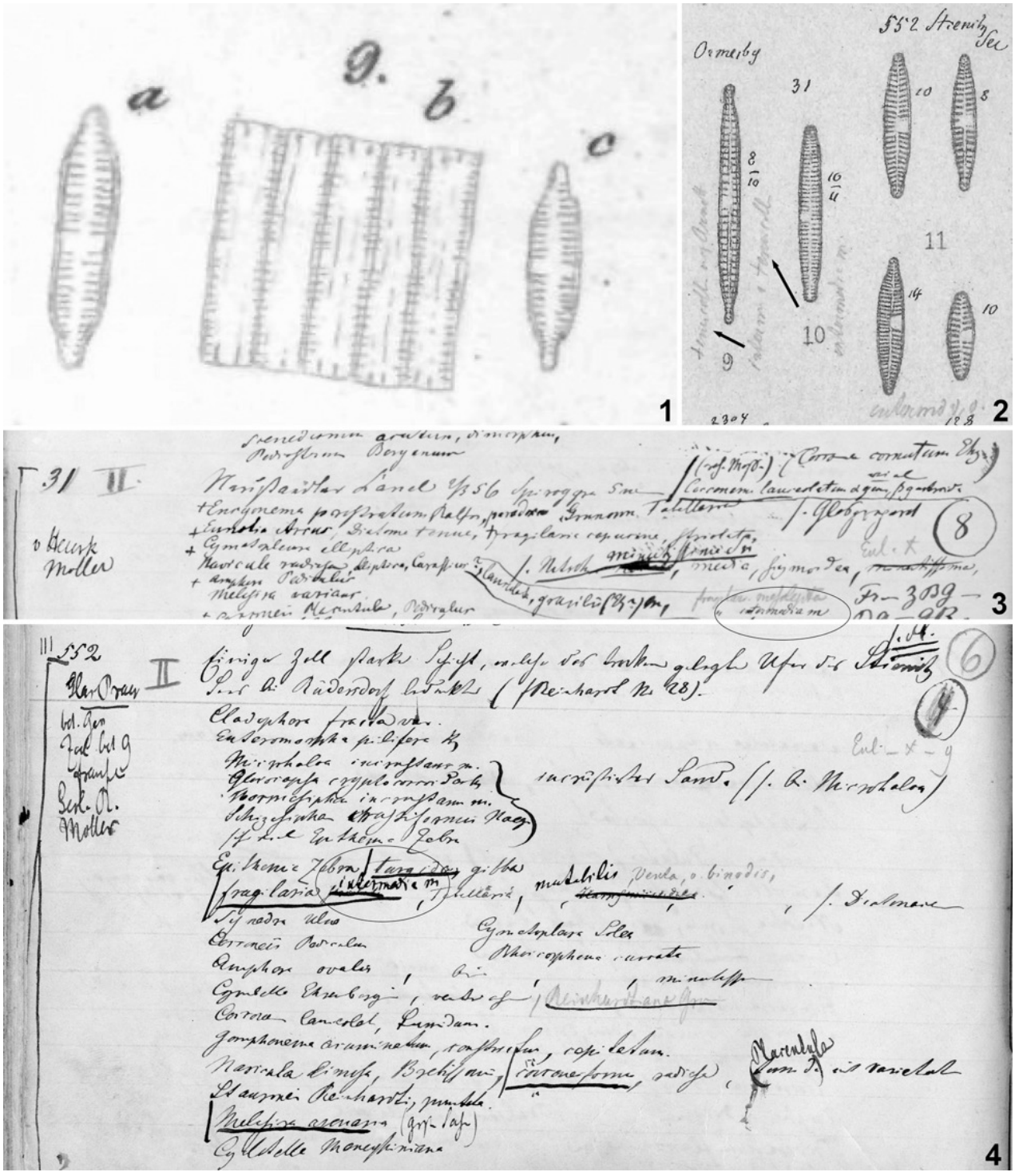
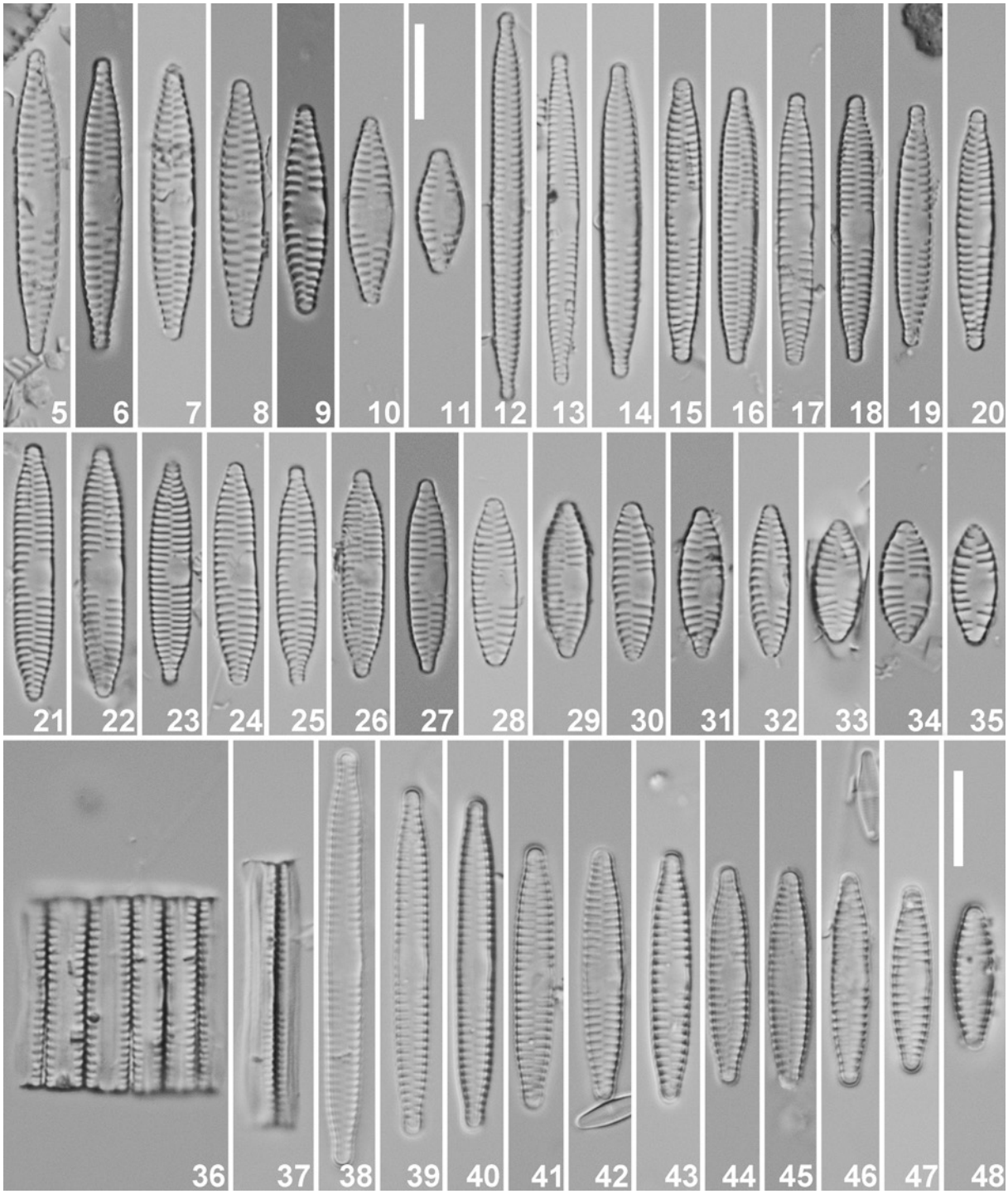
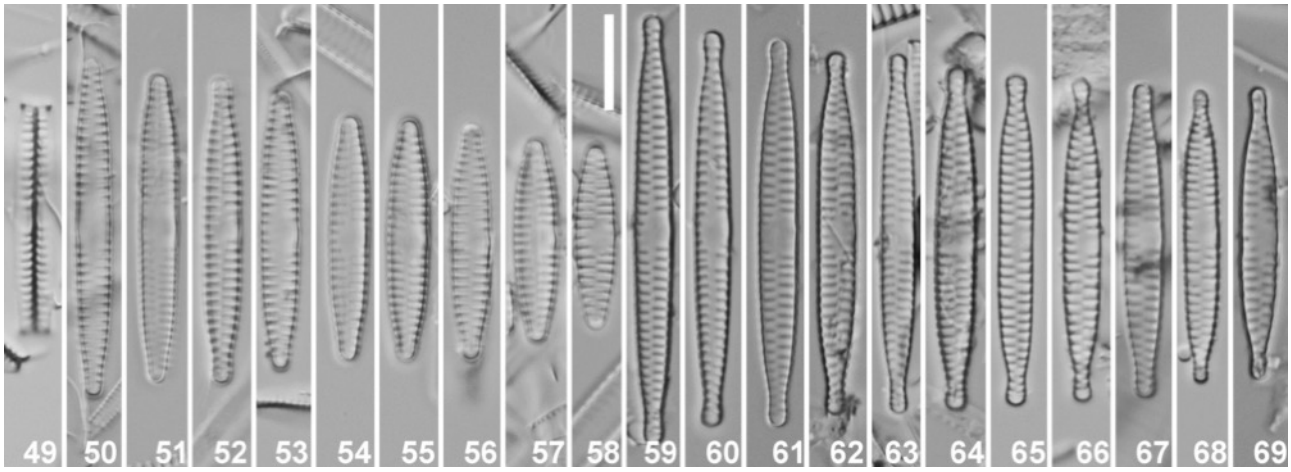



**Figs 1–4**. **Original drawings and notes by Albert Grunow documenting the taxonomic history of *Fragilaria intermedia***. **Fig. 1.** Drawing in Grunow (1862, pl. IV: fig. 9) illustrating the ribbon-like colonies and the valve face of *F. intermedia*. **Fig. 2.** Drawings in Van Heurck (1881, plate XLV, figs 9–11) showing illustrated valves from three different localities [Ormesby (9), sample 31 (10) and sample 552, Stienitz See (11, four valves). The black arrows indicate the name '*tenuicollis*'. **Figs 3 & 4**. Scans of the original species list for sample 31 (Fig. 3) and sample 552 (Fig. 4) taken from Grunow's annotation books. The black circles indicate the name '*intermedia*'.




**Figs 5–48. Light microscopy observations of *Fragilaria* valves from Grunow samples 552 (Figs 5–35) and 31 (Figs 36–48).** Note the three different taxa observed in sample 552 (Figs 5–11, 12–20, 21–35) not forming ribbon-like colonies and the colony-forming taxon in sample 31 (Figs 36–48) with Fig. 36 representing at least six frustules linked together to form a ribbon-like colony. Also note the illustrated valves of sample 31 with lack of focus. Scale bars represent 10 µm.




**Figs 49–69. Light microscopy observations of *Fragilaria* valves from Walker Arnott sample 915**. Figs 49–58 represent a taxon producing ribbon-like colonies whereas Figs 59–69 show valves of a taxon not forming colonies. Scale bar represents 10 µm.