A NOTE ON CLOSED LEAF-SHEATHS IN ZINGIBERACEAE-ZINGIBEROIDEAE

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ABSTRACT. Evidence is presented of the occurrence of closed leaf-sheaths in the subfamily Zingiberoideae of Zingiberaceae which was previously considered to have only open leaf sheaths. In several species of *Roscoea* and in *Cautleya gracilis* (Sm.) Dandy the leaf sheath is totally closed. In *Roscoea cautleoides* Gagn. the primary bracts are also sometimes tubular, whereas *R. humeana* Balf. f. & W. W. Sm. showed no tubular bracts.

In the course of growing several species of *Roscoea* for cytological and morphological study, I was struck by the fact that the leaf-sheath was closed in all cases throughout its length, and not open as is very generally asserted in the literature for the Zingiberoideae. This is shown in Plate 3: A, *R. cautleoides* Gagn.; B, *R. humeana* Balf. f. & W. W. Sm.; C, *R. procera* Wall.; D, *R. purpurea* Smith. Exactly the same condition was observed in *R. alpina* Royle and in *Cautleya gracilis* (Sm.) Dandy. So far I have only observed this peculiarity in these two genera.

It is interesting to trace the history of the idea that open leaf-sheaths are an invariable characteristic of this subfamily. Apparently, Blume (1827) was the first to point out that in *Costus*, the only genus of his subdivision (tribe) Costae, the "leaf-sheaths are tubular and not as in the other plants of this family semi-sheathing". This statement is a perfectly valid one for the plants that Blume was describing, namely those of Java and the adjacent islands, and although the genus *Roscoea* had been described some years earlier (Smith, 1805), it is unlikely that Blume was familiar with these plants, whose country of origin was so far removed from his own field of study. However, despite a total silence in the various texts on the nature of the leaf-sheath of *Roscoea*, a study of the figures already published [e.g. Smith (1805) of *R. purpurea*; and W. J. Hooker (1825) of the same species] clearly shows the closed condition of the sheath in this genus.

The erroneous assumption, that Blume's generalization that the leaf-sheaths of Zingiberaceae are universally of the open type except in *Costus*, was repeated with various degrees of definiteness by successive authors. Endlicher (1836–41) merely remarks that the sheath in this family is "longitudinally split, very rarely closed", and gives *Costus* as the only mentioned exception without asserting that they are unique in this respect. In the meantime several further illustrations of *Roscoea* had appeared showing its closed leaf-sheath (*R. purpurea*, Bot. Cab., 1828; *R. purpurea*, Roscoe, 1828; *R. procera* and *R. capitata*, Wallich, 1832).

Horaninow (1862) was rather more circumspect in that while he makes use of the "tubular and ocreate leaf-sheaths" as a diagnostic character for his tribe Costeae, he avoids a definite statement about all the rest. However, he too includes a figure of *R. purpurea* (tab. III) which, although badly drawn, does once again show the closed sheath.

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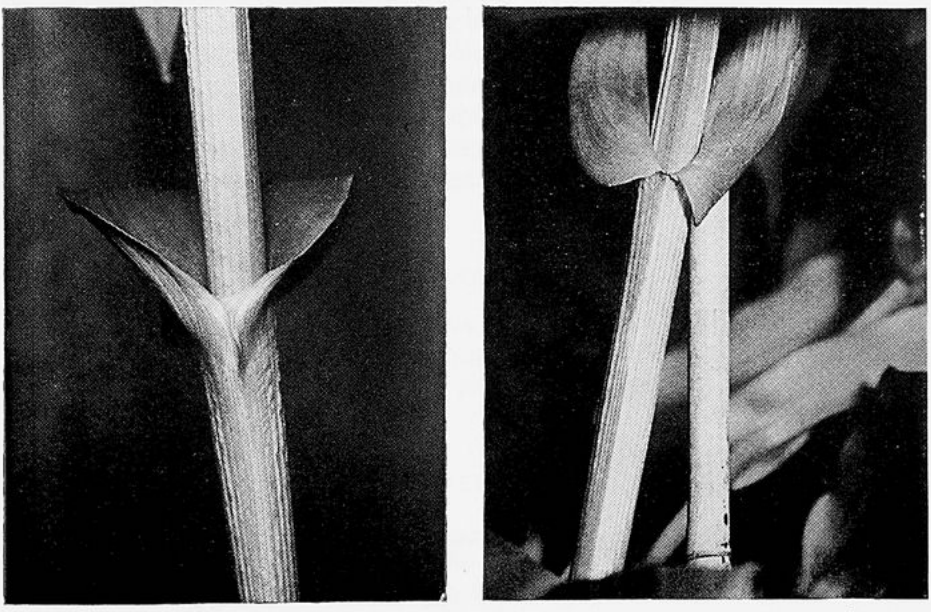
Schumann, to whom we owe the separation of the Zingiberaceae into two subfamilies, Zingiberoideae and Costoideae (1899), was working on Malaysian and Papuan plants at the time, and this may well have been the reason why he fell into the error of making the leaf-sheath one of the key characters in their separation, viz. "sheaths open" in the former and "sheaths closed" in the latter. However, when he wrote his definitive monograph of the whole family (1904), he retained this wording and even emphasized his belief in the "ausnahmslosen Konstanz" of both the sheath differences and (correctly) the phyllotactic differences in the two subfamilies, and this despite the fact that his own illustrations of *R. purpurea* (fig. 16C) and of *C. gracilis* (sub. *C. lutea*) (fig. 17A) clearly show the totally closed sheath in these species. This mistaken idea, having appeared in a work so widely accepted as authoritative, was copied uncritically by most subsequent authors (Loesener, 1930; Tomlinson, 1956, 1969; Panchaksharappa, 1962; Hutchinson, 1973). On the other hand, Nakai (1941), who proposed the elevation of the Costoideae to family rank as Costaceae, avoided this error by totally ignoring the character of the leaf-sheath in his Zingiberaceae (i.e. Zingiberoideae K. Schum.). Holttum (1950), in his account of the Zingiberaceae (s.l.) of Malaya, although he makes use in this regard of Schumann's wording in the separation of the two subfamilies, is evidently aware of the fact that the situation is not as clear cut as this implies. He points out (p. 5) that in the "*Alpinia* type of shoot" the sheaths are "tubular near the base only". This is demonstrably true, although it is often a matter of great difficulty to determine with a hand-lens if and to what degree the margins of the sheath are coalescent at the base; however, published figures of microtome sections leave no doubt that it is a fact (e.g. Boyd's, 1932, fig. 44 iii of *Hedychium gardnerianum*; Weisse's, 1932, figs. 2 & 3, taf. VIII, of *H. coccineum* and *H. coronarium* resp.), although the fraction of the total length that is coalescent in other genera than *Roscoea* and *Cautleya* seems always to be very small. A very unambiguous illustration of a cross-section of the leaf-sheath of *R. auriculata* is given by Olatunji (1970), although he makes no comment on the fact that the sheath is completely closed.

Holttum (1950) has further discussed the occurrence of tubular or cup-shaped secondary bracts in the inflorescence of the Zingiberaceae, and suggests tentatively that "as the bases of leaf-sheaths throughout the family are tubular, it seems reasonable to regard the tubular form as the most primitive". The occurrence of fully closed sheaths in the foliage leaves of *Roscoea* suggested that the bracts should be examined also. I have not so far had the opportunity to do so except in *R. cautleoides* and *R. humeana*, where I found in the former that the *primary* bracts (there are no secondary ones, i.e. bracteoles) are sometimes tubular, i.e. closed throughout the greater part, up to more than threequarters of their length. There seems to be great variability, even in the same inflorescence, in this respect. The bract subtending the fourth flower in a spike has been found to be tubular, whilst the lower ones did not show this character—this may possibly be due to splitting as the lower buds expanded. On the other hand, the lowest bract is sometimes tubular (fig. 1), while upper ones are open to the base. Examination of inflorescences of *R. humeana* has shown only bracts which are open right to the base. As far as I am aware, tubular primary bracts have not previously been described in this family, but their occurrence in *Roscoea* is scarcely

A B



C D

PLATE 2. Leaf sheath of: A, *Roscoea cautleoides*; B, *R. humeana*; C, *R. procera*; D, *R. purpurea*.

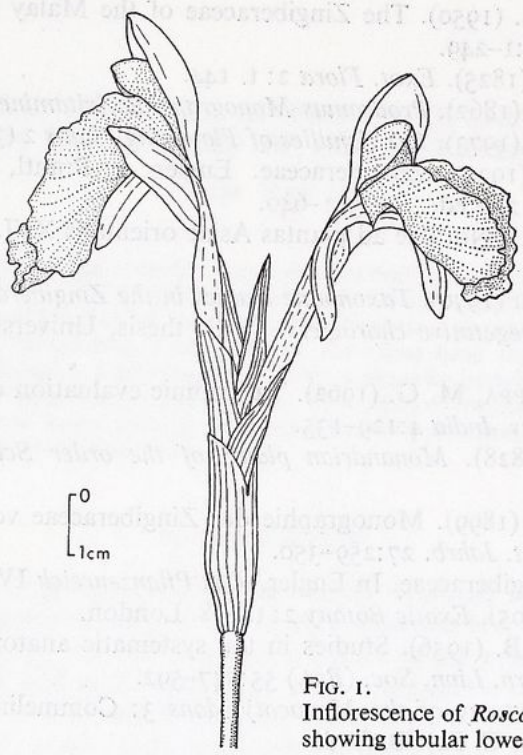


FIG. 1.
Inflorescence of *Roscoea cautleoides* showing tubular lowest bract.

surprising, in view of its vegetative structure. Whether the closed sheath and the tubular form of bract should be regarded as primitive or derivative characters is not clear, but in one vegetative feature at least we can say that the differences between the Zingiberoideae and the Costoideae are not as great as has been thought. Moreover, the relationship between distichous leaf arrangement and open sheaths in this family, which Schumann (1904) considered to be directly connected with one another, is manifestly not an obligatory one, however generally these two may go together.

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