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Mai A. TAHA & Usama Y. ABOU-SALAMA

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Recording a syncarpy form and the first abnormal capsule lid worldwide in *Byum dichotomum* Hedw. population of Saudi Arabia

Mai A. TAHA
Usama Y. ABOU-SALAMA
Department of Botany, Faculty of Science,
Ain Shams University, Abbassia, Cairo (Egypt)
maitaha33@yahoo.com (corresponding author)

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ABSTRACT
After quite a while, since 1950, from recording syncarpy "or double capsules" phenomena, the syncarpy is reported in the current study on a sporophyte of *Byum dichotomum* Hedw. In addition, we record a deformation case of a lid for one capsule carried by the same species to another individual of *B. dichotomum* population for the first time worldwide. *Byum dichotomum* was found growing on moist, shaded inclined land of Al-Shafa road, Taif Province in Saudi Arabia. The syncarpy phenomenon and the appearance of an abnormal lid have been discussed and illustrated.

KEY WORDS
Syncarpy,
double capsules,
abnormal lid,
Byum dichotomum Hedw.,
Saudi Arabia.

RÉSUMÉ
Signalement d'une forme de syncarpie et pour la première fois au monde d'un opercule anormal sur une capsule dans une population de Byum dichotomum *Hedw. en Arabie saoudite.*
Alors que la première syncarpie ou «capsule double» a été signalée dans les années 1950, notre étude décrit ce même phénomène dans le sporophyte de *Byum dichotomum* Hedw. De plus, pour la première fois dans le monde, nous enregistrons un cas de déformation d'un opercule pour une capsule portée par la même espèce d'un autre individu de la population de *B. dichotomum*. *Byum dichotomum* a été trouvé sur des terres inclinées humides et ombragées de la route Al-Shafa, dans la province de Taif en Arabie Saoudite. Le phénomène de syncarpie et l'apparition d'un opercule anormal sont discutés et illustrés.

MOTS CLÉS
Syncarpie,
doubles capsules,
opercule anormal,
Byum dichotomum Hedw.,
Arabie Saoudite.

INTRODUCTION

In excess of 4000 specimens which were gathered previously (from 1999 to 2003) from Taif Province in Saudi Arabia by the second author and kept in CAIA (Ain Shams University herbarium, Cairo, Egypt) without full identification (just at family level). In 2005, the first paper of a series concerned with these specimens (*c*. 4000) has been published, which studied Funariaceae family (Abou-Salama *et al.* 2005). Recently, the second paper in this series, which was concerned with the Grimmiaceae family has been published by Taha (2019).

While going through the third study of this series, concerned with Bryaceae family, the authors noticed two cases of abnormalities in the same population of *Byum dichotomum* Hedw.; one of them was called syncarpy or double capsules formations and the second one was recorded for the first time worldwide in the current study which was, an obvious swollen tip of a capsule lid for the same species in another individual of the population. Descriptions, illustrations and comments of the two abnormality cases are given.

MATERIAL AND METHODS

One mixed sample "U 2160" was found growing on moist, shaded inclined land on the side of Al-Shafa road, Taif Province, Makkah, South Hejaz region in Saudi Arabia at 21°08'N, 40°19'E; *c*. 880 m above sea level. The herbarium material was gathered on 14 March 2002, by Abou-Salama (the second author) and has been kept at CAIA.

The dried sample "U 2160" hydrate was placed into a Petri dish and pre-examined carefully by using a stereo binocular microscope (Euromex microscopes Holland: 110-240 Y, 50/60 Hz, WF 10 ×/20 mm) to separate different species. Each specimen was separated and kept after drying in a paper packet, serial numbers U 2160 a-d, in CAIA till further investigation. The studied specimen was hydrated on a glass slide and cleaned gently by using needles to remove sticking soil particles. To achieve cleanness, the specimen was soaked in drops of highly diluted glycerin (100% purity) for 5-10 minutes with continuous heating and then gentle tapping on the specimen by a needle. The whole plants of the specimen were transferred to a clean glass slide and mounted in a glycerin jelly to make a permanent slide. Identification of the studied specimen depends mainly on abundant green axillary bulbils at leaf axils, leaf shape, in addition to its sporophytic characters. Photographs were taken with a Fujifilm digital camera (13 Megapixels, 4 × zoom).

RESULTS

Just very fast examinations of *c*. 1400 mixed moss samples have been collected from Taif Province, South Hejaz region in Saudi Arabia resulted in recognition *c*. 4000 moss specimens in several moss families; about half of them (*c*. 2000 specimens) belonging to Bryaceae. Recently; the authors studied some of these Bryaceae specimens and during the examinations of this study, they noticed that one of the Bryaceae specimens has double capsules (Fig. 1A-D) and also in the same populations there is another abnormality in a capsule lid of one Bryaceae individuals (Fig. 1F, G).

After investigation of the specimen "U 2160a" and depending on both of the gametophetic and sporophytic characters we determined that it is *Byum dichotomum* Hedw. (Cosmopolitan species) and growing associated with three Pottiaceae taxa. It is worth mentioning, the two reported abnormalities only occurred once over the course of fast examination (2000 Bryaceae specimens).

The studied *B. dichotomum* gametophytes which were without sporophyte were up to 6.5 mm high, whereas gametophytes carrying sporophytes typically were shorter (3-5 mm). Leaves concave, broadly ovate to ovate-lanceolate, 0.5-1 mm long, 0.3-0.4 mm wide at mid-leaf; margins unbordered, slightly serrate at leaf tips; apex long acuminate; costa percurrent to short excurrent; abundant green axillary bulbils; leaf primordia present; rhizoidal gemmae occasionally present. Sporophyte up to 22 mm long; seta varying in length 12-20 mm, curved at tip; capsule dark red, reddish brown in color, pendulous, inclined, oval to sub-cylindrical shape, 1.3-2 mm long, 0.7-1 mm wide; lid mammillate-rostellate shape, 0.5-0.7 mm long.

The first abnormality observation was double capsules (Fig. 1A-D) which were relatively different in size and color; where the larger one was *c*. 1.8 mm long, 1 mm wide at the middle and lighter in color, while the smaller was 1.3 mm long and 0.7 mm wide, dark red color (Fig. 1C, D). The second abnormality observation was a swollen tip of the capsule lid (Fig. 1F, G). The abnormal lid fell at the beginning of the specimen examination.

The abnormal plants, whether in double capsules or in swollen tip of the lid, don't differ in sporophytic and/or gametophytic characters (e.g., seta length, Fig. 1E), compared with the other normal ones (in the same specimen); even size of the capsules were inside the range of dimensions which have been measured (Fig. 1E).

DISCUSSION

Syncarpy means fusion of the carpels of the gynoecium in a compound ovary (Armbruster *et al.* 2002). Despite, it is a key and the dominant feature of angiosperm evolution (Armbruster *et al.* 2002), but it was an uncommon phenomenon in Bryophytes (Henry & Andrews 1939). Since, a long time ago (i.e. five decades back) many biologists (e.g., Schimper 1861; Bescherelle 1865; Lyon 1905; Györffy 1934, 1940, 1947; Henry & Andrews 1939; Stefureac 1947; Lowry 1949; Watson 1950) noticed the syncarpy phenomenon in different moss species (about 13 species belonging to different families), by approximately four forms of appearance.

Syncarpy was an interesting and controversial phenomenon at the same time, where many explanations have been discussed depending on the appearance of the syncarpy phenomenon. Schimper in 1861, Bescherelle in 1865 and Henry & Andrews

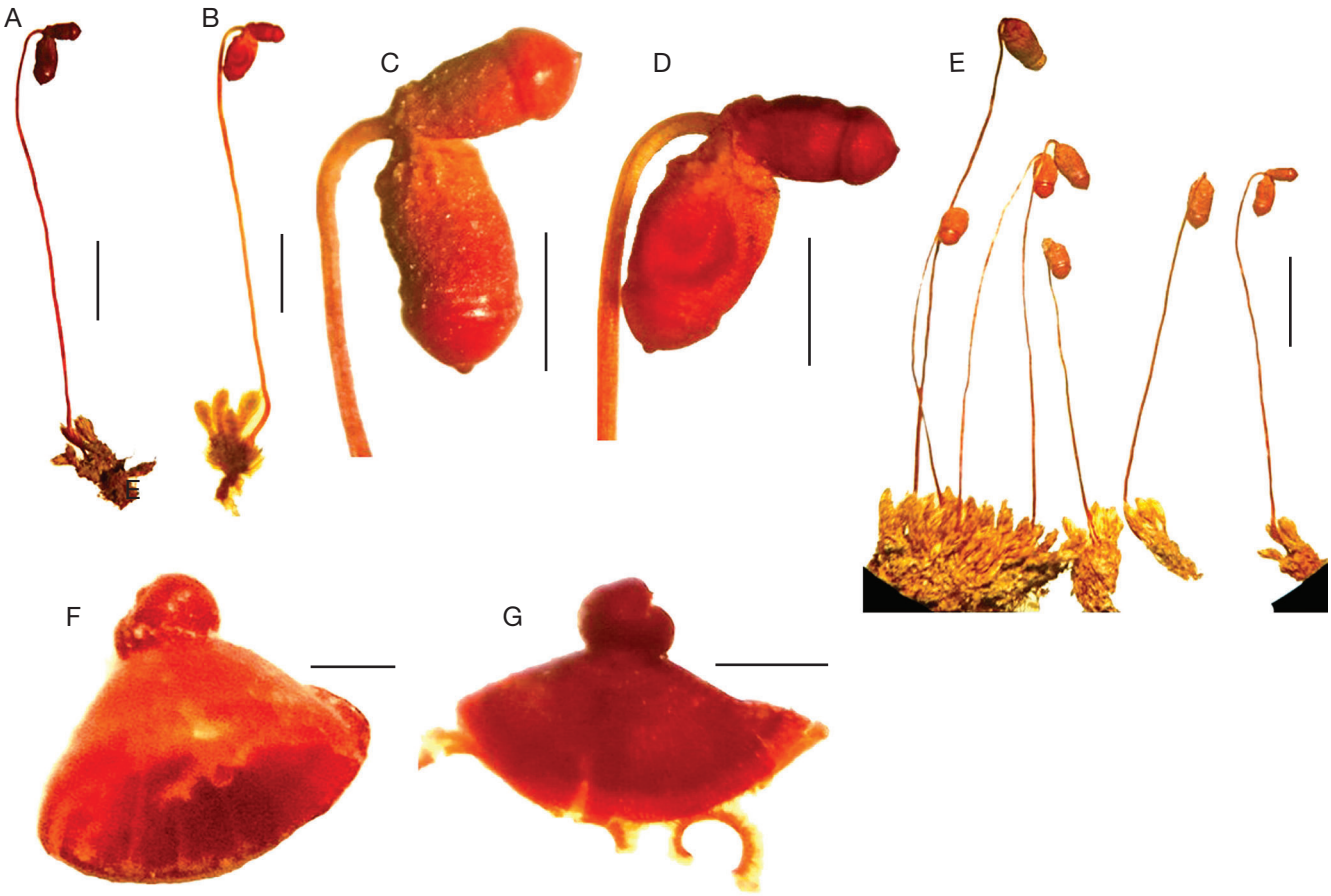

FIG. 1. — *Byum dichotomum* Hedw.: **A**, **B**, dry and wet plants carrying double capsules; **C**, **D**, magnified dry and wet double capsules; **E**, part of the plant population showing variation in seta length and capsule size; **F**, **G**, dry and wet lid showing abnormal swollen tip. Scale bars: A, B, 3 mm; C, D, 1 mm; E, 4 mm; F, G, 350 µm.

in 1939 explained the presence of syncarpy as a result of the lateral fusion of two adjacent fertilized archegonia at their venter regions, whereas Lyon in 1905 and Lowry in 1949 referred to the fertilization of two eggs in one archegonium venter resulting in the syncarpy. Also, Lowry (1949) gave other explanations for syncarpy occurrence as the double capsules formed as a result of branching of the seta at an early stage in its growth and the degree of doubleness depending on how early branching took place. On the other hand, Watson (1950) explained appearance of syncarpy as resulting in a cleavage in the tip of the embryo sporophyte, while the equality or inequality in the size between the two capsules depends on whether the cleavage was median or otherwise.

According to Watson (1950), that syncarpy phenomenon either affected the seta length (in three forms Fig. 2A-C) or affected only the distal two-thirds of the capsule (Fig. 2D) as in our study (Fig. 1A-D). Watson (1950) explained two forms (Fig. 2A, B) which affected seta length of syncarpy (out of three), by non-median cleavage in the embryo which extended to different levels in the seta-forming tissue. The third form of syncarpy affected seta length (Fig. 2C), explained by median cleavage of the embryo which extended deeply into the seta-forming tissue (Watson 1950). In the studied case here, the double nature did not reach into the seta tissue, but only formed double capsules on the same seta. Therefore, explanations below will be focused on this form of syncarpy.

In this regard, the appearance of double capsules with a common seta, as our studied case, can be discussed by three possibilities: the first one is lateral fusion of two adjacent fertilized archegonia (Bescherelle 1865), the second is a fusion of two eggs in the venter of an archegonium (Lyon 1905), while the third one is the cleavage in the tip of the embryo (Stefureac 1947; Watson 1950).

Although Bescherelle (1865), Stefureac (1947) and Watson (1950) discussed this case, but in all their cases the twin capsules were equal in size, in contrast with unequal ones in the studied case here, which was identical to one of *Sphagnum* polyembryony cases illustrated by Henry & Andrews (1939). The two capsules in the studied specimen not only differed in size but also differs in color which had attained to different degrees of development, however the doubles having the lid still intact (means not fully developed). This best fits the hypothesis of non-median cleavage of the embryo, which extends only to the distal two-thirds of the capsule level.

It is noteworthy that, both of Bescherelle (1865) and Watson (1950) claimed that *Bryum atropurpureum* W. & M. synonym of *Pohlia atropurpurea* (Wahlenb.) H. Lindb. synonym of *Pohlia annotina* (Hedw.) Lindb.) (https://www.tropicos.org/

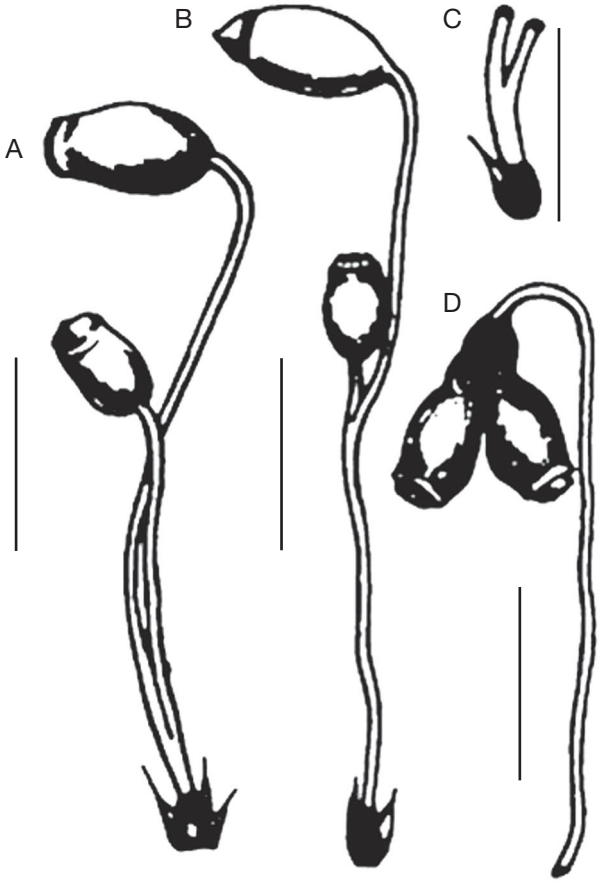

Fig. 2. — An illustration referred to Watson (1950) showing *Bryum atropurpureum* W. & M. in four forms of syncarpy: **A**, **B**, showing syncarpy phenomenon affecting unequal seta length and capsule size; **C**, shows nearly equal length of seta; **D**, shows double capsules on a common seta. Scale bars: A-D, 2 mm.

2020) had formed a syncarpy, but the shape of the capsule in *B. atropurpureum* (invalid) according Bescherelle (1865) was completely different from that of *B. atropurpureum* by Watson (1950) (Fig. 2). So, from our view, the two species were certainly different. *Bryum atropurpureum* W. & M. in Watson (1950) was crucially incorrectly identified, or most probably this specimen (by different authors: *Bryum atropurpureum* Bruch & Schimp. nom. illeg.) actually became a synonym of *Bryum dichotomum* Hedw. (Ros *et al.* 2013), particularly depending on the shape of the capsule, which was identical with the studied specimen here.

The swollen tip of the capsule lid was the first noticed worldwide, so the explanation of this appearance (in our view) may be attributed to very late disturbance of the cleavage of the distal tip of the embryonic sporophyte or may be as a result of disturbance in late division steps of the capsule of the sporophyte.

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REFERENCES

Abou-Salama U. Y., Al-Humiany A. A. & Shabbara H. 2005. — Towards a moss flora of Taif and its vicinities, Saudi Arabia.1- Funariaceae. *Taeckholmia* 25: 1-14. https://taec.journals.ekb.eg/article_12301.html

Armbruster W. S., Debevec E. M. & Willson M. F. 2002. — Evolution of syncarpy in angiosperms: theoretical and phylogenetic analyses of the effects of carpel fusion on offspring quantity and quality. *Journal of Evolutionary Biology* 15: 657-672. https://doi.org/10.1046/j.1420-9101.2002.00414.x

Bescherelle E. 1865. — Note sur deux cas de syncarpie observés sur le *Bryum atropurpureum*. *Bulletin de la Société botanique de France* 12: 291-295. https://doi.org/10.1080/00378941.1865.10825033

Györffy I. 1934. — Doppelte Mooskapseln aus Frank reich. *Revue Bryologique* 7: 117-121.

Györffy I. 1940. — Fission der Kapeel von *Orthotrichum affine* aus Bulgarien. *Bulletin de l'Institut royal des Sciences naturelles de Belgique* 13: 207-209.

Györffy I. 1947. — Muscorum abnormalia et terata in Horto Botanico Universitatis Claudiopolitanae. *Buletinul de Informatii al Grădinii botanice Cluj* 27: 164-180.

Henry N. & Andrews J. R. 1939. — An apparent double-sporophyte in *Polytrichum commune* L. *Torreya* 39 (3): 69-72. https://www.jstor.org/stable/40597220

Lowry R. J. 1949. — Clustered sporophytes in Mosses. *American Journal of Botany* 36: 529-32. https://doi.org/10.1002/j.1537-2197.1949.tb05301.x

Lyon H. L. 1905. — Polyembryony in *Sphagnum*. *Botanical Gazette* 39: 365-366. https://www.journals.uchicago.edu/doi/pdfplus/10.1086/328629

Ros R. M., Mazimpaka V., Abou-Salama U., Aleffi M., Blockeel T. L., Brugués M., Cros R. M., Dia M. G., Dirkse G. M., Draper I., El-Saadawi W., Erdağ A., Ganeva A., Gabriel R., González-Mancebo J. M., Granger C., Herrnstadt I., Hugonnot V., Ibrahim K., Kürschner H., Losada-Lima A., Luis L., Mifsud S., Privitera M., Puglisi M., Sabovljević M., Sérgio C., Shabbara H., Sim-Sim M., Sotiaux A., Tacchi R., Vanderpoorten A. & Werner O. 2013. — Mosses of the Mediterranean, an annotated checklist. *Cryptogamie, Bryologie* 34: 99-283. https://doi.org/10.7872/cryb.v34.iss2.2013.99

Schimper W. P. 1861. — Observations sur quelques cas de teratologie bryologique. *Bulletin de la Société botanique de France* 8: 351-353. https://doi.org/10.1080/00378941.1861.10829582

Stefureac T. I. 1947. — Sporogone ä capsules géminées chez *Oncophorus virens* (Sw.) Brid. *Bulletin of the Russian Academy of Sciences* 29: 618-626.

Taha M. A. 2019. — Towards a moss flora of Taif and its vicinities, Saudi Arabia. 2- Grimmiaceae. *The Egyptian Journal of Experimental Biology (Botany)* 15: 365-375. http://egyseb.net/fulltext/15-1570856386.pdf?1587279614

Watson E. V. 1950. — Four Cases of Syncarpy or 'Double-Capsules' in a Population of *Bryum atropurpureum* W. & M. *Transactions of the British Bryological Society* 1: 345-348. https://doi.org/10.1179/006813850804878806

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