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A NEW SPECIES OF *APLODONTOPUS* (ACARI: ASTIGMATA: CHORTOGLYPHIDAE) FROM THE YELLOW-BELLIED MARMOT, *MARMOTA FLAVIVENTRIS* (RODENTIA: SCIURIDAE) IN EASTERN WASHINGTON, USA, WITH OBSERVATIONS ON ITS PATHOLOGY*

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ABSTRACT - The deutonymph of a new species of the chortoglyphid genus *Aplodontopus* is described from a population of *Marmota flaviventris* occupying a city park in eastern Washington state, USA. Many of the mite-infested individuals displayed hair loss ranging from 20-100%, along with a variety of tissue and histological abnormalities. A key to the deutonymphs of described species of *Aplodontopus* is presented.
Key words - Acari, Chortoglyphidae, *Aplodontopus*, yellow-bellied marmot, host pathology, USA.

INTRODUCTION

The family Chortoglyphidae is a small relictual lineage of nidicolous glycyphagoid mites that are found primarily in association with the rodent families Sciuridae, Muridae, and Heteromyidae in North America and Asia (OConnor, 1982). As in certain other nest-inhabiting glycyphagoid families, chortoglyphid deutonymphs (hypopodes) live in the hair follicles of their mammal hosts and apparently derive nourishment from the invaded host tissues, despite their lack of a mouth and a functional digestive system. This invasion of hair follicles may lead to the development of typically low-grade pathological symptoms in the host animal such as flaking of skin cells, follicular keratosis, and disruption of dermal connective tissues (Tadkowski and Hyland, 1979). However, deutonymphs of an undescribed chortoglyphid species recently were found to be associated with a more serious pathological condition in a sciurid rodent previously unrecorded as a host for this family.

The yellow-bellied marmot, *Marmota flaviventris* (Audubon and Bachman), is common in lava beds and on rocky outcrops and talus slopes in western North America in areas where there is an abundance of succulent vegetation (Verts and Carraway, 1998). Marmots often take advantage of human habitations and highway construction sites, utilizing fence post piles, mine tailings, outbuilding crawl spaces, and roadside rock debris for nesting and for reproduction (Maser *et al.*, 1979). Habitat disruption and hunting pressure may have played a role in their invasion and colonization of more heavily populated urban sites where their presence would once have been considered an oddity. An extreme example of urban invasion may be found in Spokane, Washington, where yellow-bellied marmots living in a downtown city park have become so numerous as to be considered a nuisance.

Growing concern for human safety led to recent initiation of a trapping program by park officials to reduce marmot numbers there. A total of 132 individuals of *M. flaviventris* were live-trapped and euthanized in May, 2001. Many of these animals displayed severe hair loss (Fig. 1), and several were sent to the Department of Veterinary Microbiology and Pathology in Pullman, Washington, for further examination. Skin scrapings from necropsied animals contained great numbers of mites that were later determined to be deutonymphs of a new species

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Fig. 1. Mite-infested female *Marmota flaviventris* displaying 50% hair loss.

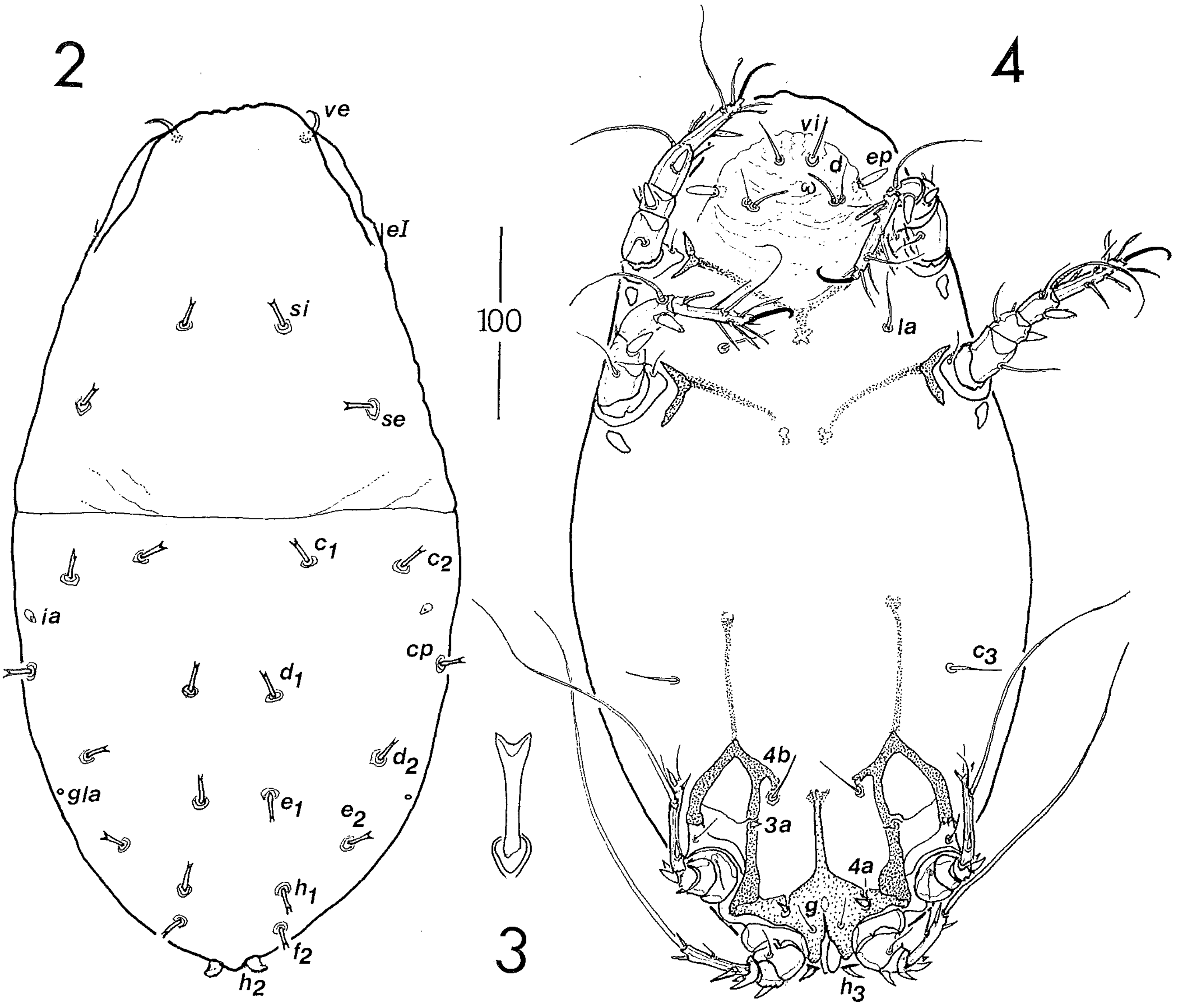
of the chortoglyphid genus *Aplodontopus*. The purpose of this paper is to describe the new species and to provide information on its symptomatology in *M. flaviventris*.

It should be noted that there is morphological evidence supporting the synonymy of *Aplodontopus* with *Chortogylphus* Berlese, the type genus of the family Chortoglyphidae (OConnor,1979). In the absence of a formal published declaration of the synonymy, however, the generic name *Aplodontopus* is retained here.

METHODS AND MATERIALS

Using a #10 scalpel blade, a series of 1cm square skin scrapings were taken from the backs and between the shoulders of the 41 marmots made available for examination (Table 1). Scrapings were transferred to glass slides in mineral oil, coverslips were added, and slides were examined microscopically at 100 to 400 magnifications for mites. Numbers of mites observed on each slide were estimated, as was the degree of hair loss on each animal (Table 1). Gross necropsies on two animals were performed by personnel at the Washington Animal Disease Diagnostic Laboratory in Pullman, Washington. Selected tissue samples were preserved in 10% buffered formalin, sectioned at 5 µm, and stained with haematoxylin and eosin for histopathological evaluation.

Slides with skin scrapings were later disassembled under a dissecting microscope and mites were washed from the mineral oil in distilled water. Individual mites were then transferred to droplets of Hoyer's medium on microslides to which coverslips were applied. Slide preparations were heated at 55°C for several hours and examined under a Zeiss laboratory microscope. Measurements of the holotype specimen given in the description presented below are in micrometers, followed by the means and ranges of measurements recorded for10 paratype specimens. Setal designations for the idiosoma and legs are derived from Fain (1969), Griffiths (1970), and Griffiths *et al.* (1990).



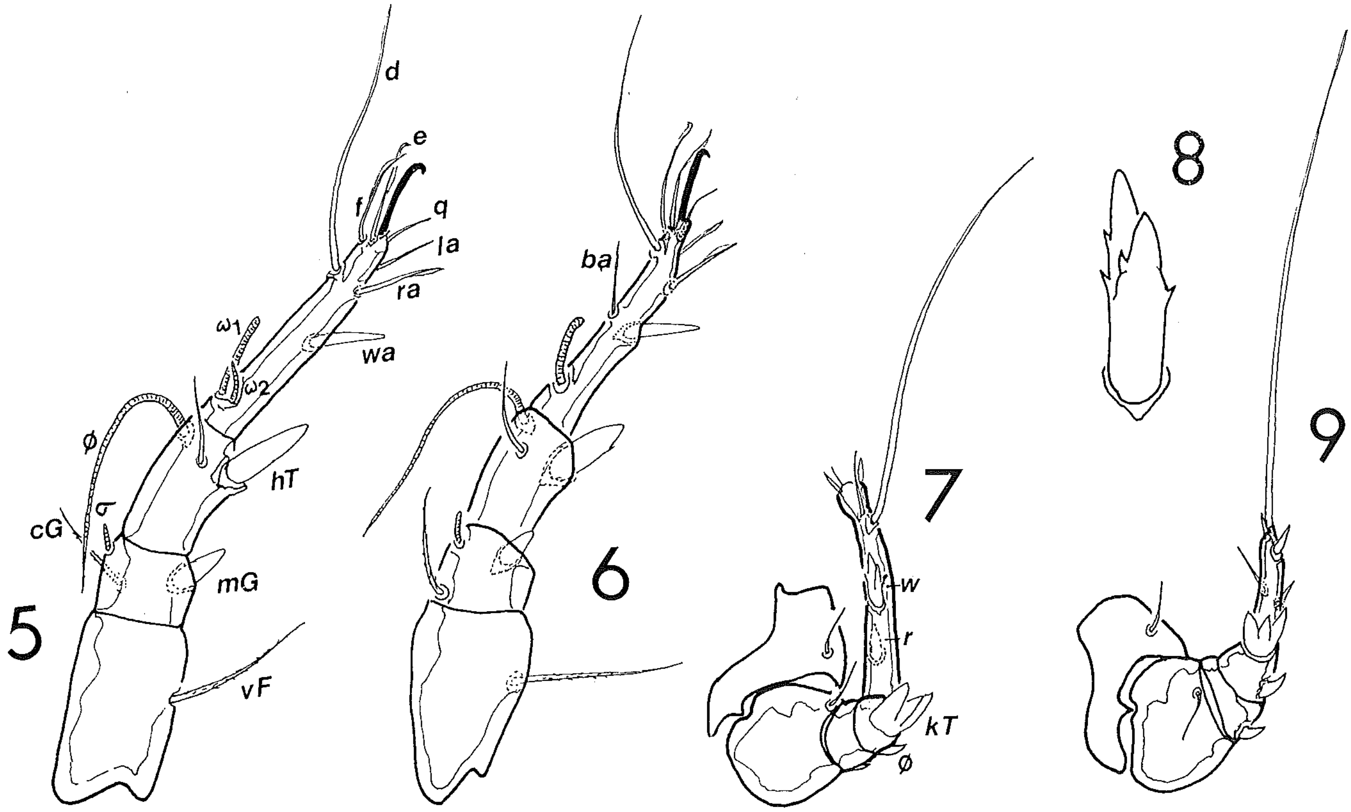
Figs. 2-4. *Aplodontopus marmotophilus* n. sp. (deutonymph) - 2. Dorsum, 3. Detail of dorsal seta *d2*, 4. Venter.

SYSTEMATICS

Aplodontopus marmotophilus n. sp. (Figs. 1-9)

DEUTONYMPH - Length of idiosoma = 430 (450, 410-470), width at level of sejugal furrow = 210 (221, 195-250). Dorsally (Fig. 2) with integument appearing smooth, propodosomatic sclerite absent, with a distinct sejugal furrow between pronotum and hysteronotum (Fig. 2); external vertical setae *ve* =13 (15, 13-18), smooth or nearly so, *si* and *se* =11 (12, 10-14) subequal in length, distally bifurcate; supracoxal setae of legs I (*e*I) = 12 (12,11-13) simple. Hysteronotum with 10 pairs of setae, of which nine are bifurcate (Fig. 3) and subequal in length to the scapulars, setae *h*2 = 6 (6, 6-7) terminal or subterminal, broad and hornlike; *h*3 (= 5 [5, 5-6]) curved, spinelike, inserted behind the more robust *h*2 and generally more easily visible in ventral mounts (Fig. 4). Opisthonotal cupules *ia* located anterolaterally between setae *c*2 and *cp*, opisthonotal glands (*gla*) open laterad at a level between insertions of setae *d*2 and *e*2.

Ventrally (Fig. 4) without ornamentation or sejugal furrow; gnathosomatic remnant distinctly rugose, with three pairs of setae and a pair of solenidia, vertical internal setae *vi* =15 (16, 14-21) robust, weakly barbed, inserted well behind anterior gnathosomatic border; setae *ep* =14 (13, 12-14) smooth or nearly so, broad and blunt distally, inserted on lateral gnathosomatic margins posterior to *vi*; setae *d* =15 (16, 12-20) hairlike, subequal in length to



Figs. 5-9. *Aplodontopus marmotophilus* n. sp. (deutonymph) - 5. Leg I, dorsolateral aspect, 6. Leg II, dorsolateral aspect, 7. Leg III, dorsal aspect, 8. Detail of seta *w*, leg III, 9. Leg IV, dorsal aspect.

solenidia ω (=17 [17, 14-20]) with which they share contiguous insertions. Coxal fields I-II demarcated by poorly defined apodemes that arise from well sclerotized, V-shaped fragments at the trochanteral bases; apodemes I joined medially and terminating at a level midway between trochanters I-II, terminus marked by a small X-shaped endosternite; apodemes II free medially, each terminating at the position of a small, Y-shaped endosternite. Setae *la* = 21 (19, 15-25), smooth and spinose, inserted equidistant from apodemes I-II. Subhumeral setae *c3* =16 (17, 15-20) smooth, similar in length to *la*, inserted laterally above coxal fields III. Apodemes of legs III-IV fused, strongly produced and contiguous with pregenital sclerite, with a pair of weakly defined apodemes that extend anteriorly well beyond setae *c3;* anterior genital setae *4b* = 12 (13, 12-14) hairlike, inserted adjacent to the hooklike internal protuberances of apodeme III, considerably longer than nearby spinose coxal setae *3a* (= 5 [4, 4-6]). Pregenital sclerite distinctly rhomboid, with a narrow anteromedian extension (= 36 [40, 33-41]) that terminates in a series of short ill-defined fingers; coxal setae *4a* (=3 [3, 3-4]), spinose, inserted in open anterior clefts on the sclerite margin, considerably shorter than the posterior genital setae *g* (= 8 [7, 7-10]), which are inserted mediad from trochanters IV and flank the terminal genital cleft; with four elongate genital suckers directed posteriorly, typically extruded from the cleft as in Fig. 4, flanked posteriorly by curved, spinose setae *h3*.

Legs I-II widely separated from legs III-IV, each terminating in a large claw; setation (Figs 5-9) parallels that of other *Aplodontopus* species, membranous flanges present on most terminal setae but weakly developed; setae *mG*, *hT*, and *wa* of legs I and II smooth or at most weakly ornamented (Figs. 5, 6), *cG* at least three times the length of adjacent solenidion σ; setae *r* and *w* of legs III-IV forked terminally, weakly barbed as illustrated (Fig. 8); seta *kT* of tibiae III-IV broadly palmate (Figs. 7, 9).

Material examined - Holotype and 25 paratype deutonymphs recovered from skin scrapings of *Marmota flaviventris*, Spokane, Washington, May, 2001 (W.J. Foreyt). Several non-paratype specimens from the same collection were earlier sent to Dr. Fain and are now deposited in the collection of the Royal Institute of Natural Sciences in Brussels. An additional two specimens from *M. flaviventris* in the Ohio State University acarology collection were identified by one of us (BMO) as being conspecific with *A. marmotophilus* and carry the following data: Red Feather Lakes, Larimer County, Colorado, 25 June1972, ex *Marmota flaviventris* (N. C. Ronald). Two unlabeled slides of *A. marmotophilus* also are deposited in the Ohio State University collection.

Type deposition - The holotype deutonymph will be deposited in the collection of the National Museum of Natural History, Washington, D.C. Paratypes will be deposited in the following collections: Museum of Zoology, University of Michigan, Ann Arbor; Oregon State University Arthropod Collection, Corvallis; Museum of Biological Diversity, Ohio State University, Columbus; Canadian National Collection, Ottawa.

Key to the known species of *Aplodontopus* (deutonymphs)

1. Coxal setae *3a* and *4a* in the form of conspicuous, rounded conoids. Associated with *Spermophilus tridecemlineatus* in eastern North America............. ....*micronyx* Fain and Spicka
   Coxal setae *3a* and *4a* in the form of tiny spines or simple setae.. 2
2. Internal vertical setae *vi* distinctly thickened, length/width ratio about 4:1; palpal supracoxal (lateral gnathosomatic) seta *ep* with distinct barbs. Associated with *Tamias striatus* in eastern North America .... *sciuricola* Hyland and Fain
   Setae *vi* thinner, length/width ratio exceeds 5:1; setae *ep* without distinct barbs. Found in western North America 3
3. Palptibial setae *d* approximately half the length of adjacent gnathosomatic solenidion ω. Associated with *Aplodontia rufa* ....*latus* Fain
   Palptibial seta *d* at least 2/3 the length of solenidion ω. Associated with *Marmota flaviventris*.................... .... *marmotophilus* **n. sp.**

DISCUSSION

Pathology - A total of 176 *Marmota flaviventris* were trapped from the isolated urban park colony in Spokane, Washington (132 specimens) and from a suburban colony 14 km west of Spokane (44 specimens). Most of the animals from the park colony (population A) were found to have hair loss ranging from 20-100%, while none of the animals from the suburban colony (population B) displayed observable hair loss. Table 1 summarizes findings on a subsample of these two populations made available to WJF.

Marmots from the population A subsample (n = 19) consisted of 7 males and 12 females with a mean weight of 1.72 kg (0.95-3.20). The subsample from population B (n = 22) comprised 9 males and 13 females with a mean weight of 2.14 kg (1.2-3.1). No mites were detected in marmots from population B, while scrapings from 17 of the 19 marmots in population A tested positive for *A. marmotophilus*. Numbers of mites from these specimens ranged from less than 5 to more than 50 per scraping. Necropsies on two of the infested marmots with more than 50% hair loss revealed a pronounced loss of subcutaneous and abdominal fat, although all of the internal organs appeared to be normal. Histologically, both animals displayed severe telogen effluvium, follicular atrophy, and a significant decrease in bone marrow fat. Mites were observed just superficial to the sebaceous gland ostia within the follicles, and the follicles themselves were moderately distended with lamellar keratin. The surrounding superficial dermis was infiltrated with small numbers of lymphocytes, plasma cells, eosinophils, neutrophils and mast cells. Other tissues were found to be largely normal.

The severity of symptoms noted in several of the mite-infested marmots in population A seemed extreme when compared to the relatively mild pathology produced by other *Aplodontopus* species on their various sciurid hosts (Tadkowski and Hyland, 1979). The protected park habitat may have allowed for expansion of the marmot population to abnormal levels, which in turn provided a greatly increased and concentrated host pool for *A. marmotophilus*. The lack of pathological symptoms and the total absence of mites in skin scrapings of the 22 suburban marmot specimens comprising population B also was unexpected, especially in light of the relatively heavy infestation levels of *A. sciuricola* seen in field populations of *Tamias striatus* (Tadkowski and Hyland, 1979). It should be noted that numbers of mites recovered from individuals in population A were not necessarily correlated with degree of hair loss (Table 1). Multiple rather than single scrapings from each animal may have provided a better basis for correlation of infestation levels with symptomatology in population A, and for confirming that population B was indeed mite-free.

Remarks on phylogeny and host relationships - OConnor (1982) has characterized the Chortoglyphidae as an ancient glycyphagoid assemblage that may have evolved in conjunction with early prototherian mammals (Multituberculata), and that succeeded in making the transition to new hosts before their original hosts became extinct. *Aplodontopus*, the earliest derivative North American chortoglyphid genus, has host associations with the relatively early-evolved rodent family Sciuridae. The antiquity of the genus is exemplified by *A. rufa* Fain, which occurs with the mountain beaver, *Aplodontia rufa*, the sole surviving species of a once extensive lineage of sciuromorph rodents that arose during the Paleocene. Like other chortoglyphid mites, the deutonymphs of *Aplodontopus* have established what appear to be host-specific relationships with their sciuromorph hosts, and it is likely that many additional species will be discovered as available hosts are examined.

Table 1. Levels of hair loss and mite infestation in *Marmota flaviventris* individuals taken from urban (A) and suburban (B) populations in and near Spokane, Washington, May, 2001. Mite infestation levels are based on numbers of specimens recovered from 1x1 cm skin scrapings (+ = 1-5 mites, ++ = 6-10 mites, +++ = 11-25 mites, ++++ = 26-50 mites, +++++ = 50 mites).

Population A

Subject No.	Weight (in kgs)	Sex	% hair loss	Number of mites
1	1.43	F	20	+++++
2	2.00	F	50	+
3	2.55	F	0	+
4	1.38	F	50	++++
5.	1.08	F	0	++++
6.	2.45	M	80	+
7.	1.10	F	0	+
8.	2.40	M	40	++++
9.	1.10	M	100	0
10.	1.00	M	100	+
11.	1.65	M	30	0
12.	0.95	F	90	+
13.	2.50	F	40	+
14.	1.65	F	50	+++
15.	2.50	F	0	++
16.	1.60	F	20	+++
17.	1.05	F	100	+++++
18.	3.20	M	0	+
19.	1.00	M	100	+
	X= 1.72			

Population B

Subject No.	Weight (in kgs)	Sex	% hair loss	Number of mites
1.	2.20	M	0	0
2.	1.40	F	0	0
3.	2.00	M	0	0
4.	1.70	F	0	0
5.	1.65	F	0	0
6.	1.70	F	0	0
7.	1.80	M	0	0
8.	1.55	M	0	0
9.	1.60	F	0	0
10.	2.30	F	0	0
11.	2.90	M	0	0
12.	2.30	M	0	0
13.	3.10	M	0	0
14.	2.50	M	0	0
15.	2.40	F	0	0
16.	2.10	F	0	0
17.	2.40	F	0	0
18.	2.60	M	0	0
19.	2.10	F	0	0
20.	3.10	F	0	0
21.	2.00	F	0	0
22.	1.60	F	0	0
	X= 2.14			

The genus *Aplodontopus* was first described from the deutonymph and included in the Glycyphagidae. After the life cycle of this species was clarified, it was included in the family Chortoglyphidae and the subfamily Aplodontopinae was relegated to synonymy with Chortoglyphidae (Fain and Spicka, 1977).

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