Karen's copy

A Genus Key to the Odonate Larvae of the Northeastern United States

Introduction

The larvae of the damselflies and dragonflies (the Odonata) are difficult to identify. Keys are most often constructed for the last larval instar (easily identified because wing pads will have grown past the 3rd abdominal segment), yet we have earlier instars or exuviae (cast skins) that may or may not to be able to be identified using the existing keys. The current published keys are difficult in practice, because nymphs tend to be secondary to the more conspicuous adults. Additionally, the people who made the keys either did not know the species well enough or too well to make a usable key, nor do they have sufficient pictures and diagrams.

My goal is to make a key that will usable and accessible to those never previously exposed to odonates. I would like to have a picture for each nymph species and character described. This key is far from ideal. Right now my goal is to make a key that will minimize frustration. When writing a key, one needs to know the species well enough to readily recognize them, while using characters that are easily distinguished by the layperson.

Along these lines, a CD-ROM dragonfly identifier for the Northeast is in the planning stages. Instead of a dichotomous key, it is a random access key, so that you can choose the any character you would like to identify the critters. Dick Mitchell, the New York State Botanist has made one for ferns. This will certainly have pictures for most larvae (as well as adults) and I hope it will make identifying a less arduous task. In the meantime, I hope this key will make things a little easier. Comments and questions are encouraged! See my address at the end of the introduction.

The Order Odonata (pronounced O-duh-nay-da, I looked it up in a biological dictionary) is divided into two major suborders: the Anisoptera, or "true" Dragonflies; and the Zygoptera, commonly called damselflies. To confuse you further, the entire order is sometimes referred to as Dragonflies. This, however, is usually used in older North American and current European literature.

There are ten families of odonates (7 Anisopteran and 3 Zygopteran) that occur in the Northeast. Donnelly (1992) reports that there are 175 species of Odonata in New York State.

Why Study Dragonflies?

Often in biology and ecology, studying a group in its own right to extend the limits of knowledge is sufficient. In today's scientific atmosphere of fiscal conservatism, researchers often must justify their research in terms of human beings. More importantly, however, we are facing a biodiversity crisis. Although the rate of extinction is debated in the literature, that human beings are drastically altering landscapes and the species which inhabit them is undeniable. Conservation is an important current issue and the study of Odonata can contribute to conservation efforts in several ways.

Invertebrates constitute 95% of all animal species and 99.5% of all individual animals known on Earth (Moore 1997). Yet most conservation efforts focus on vertebrates because they are charismatic, cute and furry. If we are to conserve biodiversity, we must conserve invertebrates as well, and one way to draw attention to species is to study them. Dragonflies are interesting, conspicuous, and beneficial to humans (as they catch mosquitoes and other insect pests as larvae and adults).

Since odonate larvae are aquatic and they are not uniformly distributed across chemical gradients (Bendell and McNicol 1987, 1995; Frolich, unpublished data; Lenz 1991; Pollard and Berrill 1992; Samways *et al.*, 1996), they could be useful indicators of biotope quality (often termed bioindicators). There are several ongoing studies (including my own) that address this issue. Most of the recent studies indicate they would be most useful as indicators for the design of constructed wetlands (Bulankova 1997; Chovanec and Raab 1997; Kenimer and McFarland 1997). Although these issues will continue to be discussed in the literature, it is clear that the presence and absence of different larval species provide some information about the ecological integrity of a water body and therefore are worthwhile study subjects.

SOME NOTES ON THE USE OF THIS KEY:

A hand lens would be useful in identifying, however a dissecting microscope may give you fewer headaches. To identify live specimens, try immersing them in soda water to sedate them so you can manipulate the body parts as necessary (I have no idea if this works, let me know if it does). Forceps are essential, I like to use 2 pair of fine tipped forceps from Carolina Biological Supply.

All family names are in capital letters (example: CORDULGASTERIDAE).
I have chosen not to separate the CORDULIIDAE from the LIBELLULIDAE, as these often can be confusing.

A prime sign (') indicates the second part of a couplet. The number in parentheses is the couplet of the character that led you to the couplet you are on. This makes it easier to backtrack if you feel you have made a mistake.

I use continuous numbers even though the family keys are on different pages. This is for ease of use, recall that this is my goal in creating this key.

For identification to species, I recommend the following:

Use Soltesz (1996) for the Anisoptera and Westfall and May (1996) for the Zygoptera. There should be another Westfall and May for the Anisoptera coming out in coming months. Watch the official website of the International Odonata Research Institute (www.afn.org/~iori) for this as well as other information on the odonate world.
A well done online key is by Ethan Bright is for Michigan species, but there are many northeastern species there. http://insects.ummz.lsa.umich.edu/MICHODO/test/Home.htm

Remember that the characters used in the key usually do not have any particular significance i.e., quantifiable characters are used to describe a body shape. After some practice, identification becomes a Gestalt exercise and you will be able to skip ahead in the key. I have tried to make illustrations (although my artistic ability is less than stellar) and to define words that may be confusing. This is my first attempt at a key, so once again any and all feedback is welcomed.

If a couplet lists more than one character and the first does not seem to fit, go to the next, it is not cheating. Organisms are variable and we have to work around that. Do not get discouraged if your specimen does not seem to fit the key, I have experienced your frustration. Sometimes it is just best to put it away and try another one.

It is worthwhile to obtain a species list for your area (if available). This helps eliminate possibilities e.g., *Sympetrum corruptum* is included on this key, but a larva of this species has never been found in NYS. It is also worthwhile to obtain a rare species list in your area (Natural Heritage programs should be able to help you here) because it is always better to be conservative in your identifications (Conservative meaning it is more likely a common species than a rare one). And if you do find a rare species you should notify your State's Natural Heritage Program.

Although I wrote this key, I have borrowed from other published keys. A complete bibliography is found at the end of the key.

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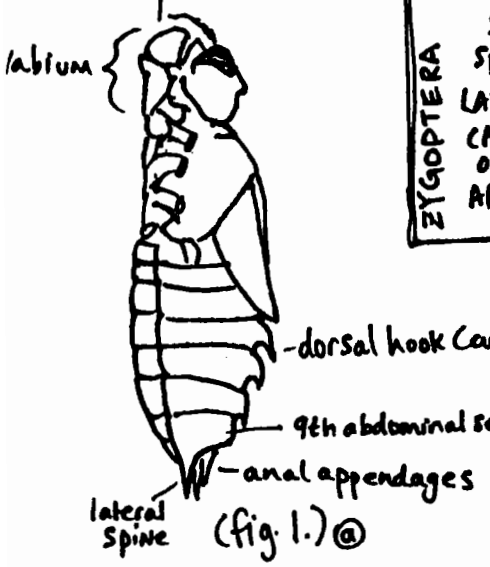
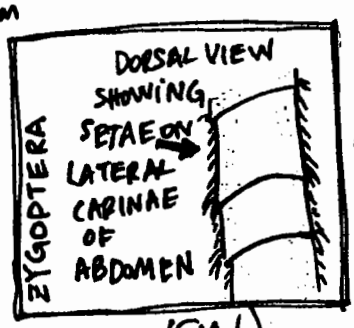
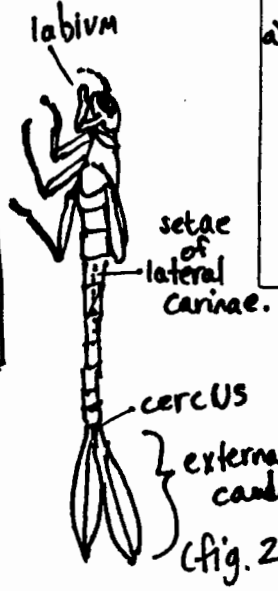
Illustrations from:
a) WESTFALL, M.J. 1987. Order Odonata. In Immature Insects, Frederick W. Stehr, Ed. Kendall/Hunt Publishing Co, N.Y.
b) Walker, 1958.
c) Westfall & May 1996.



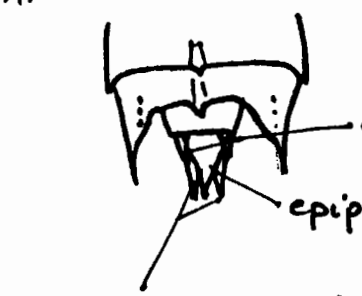
(fig. 1.) ⓐ

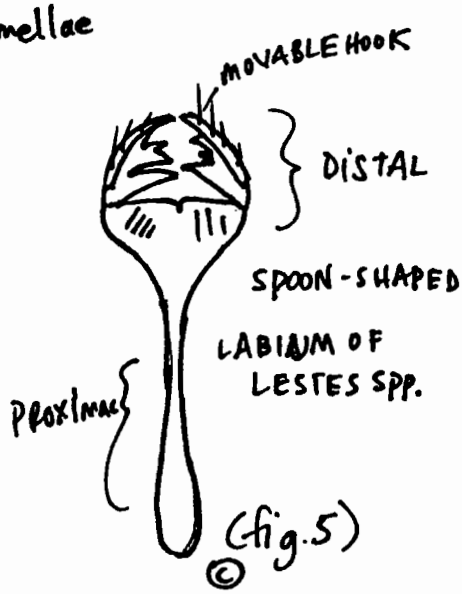


(fig. 6)



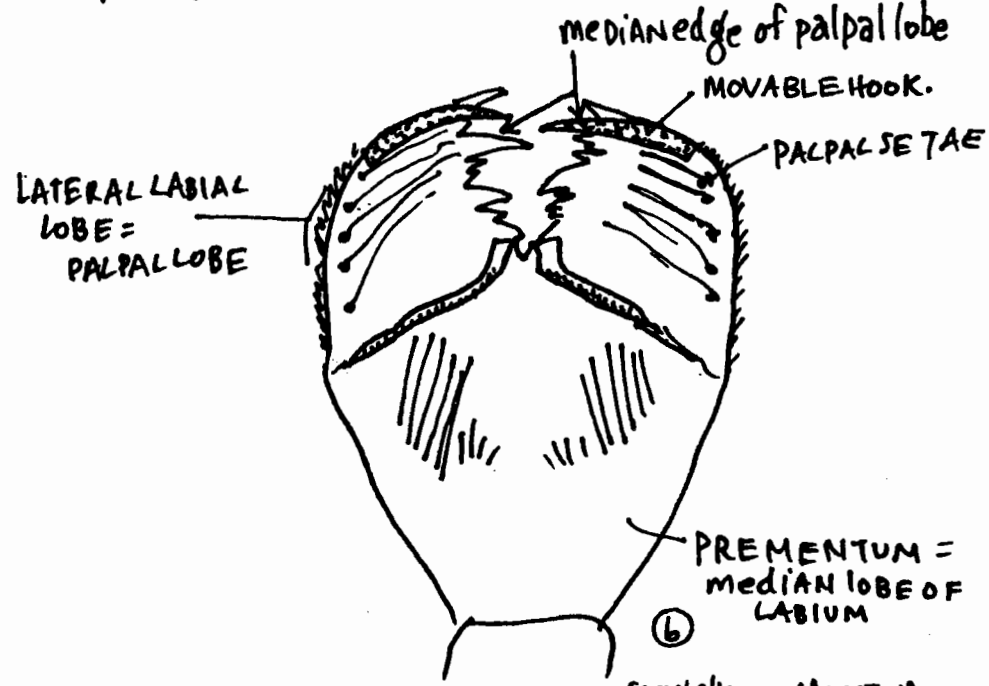
(fig. 2) ⓐ
Zygopteran larva.





(fig. 5) ⓒ

(fig. 3) ⓑ
flat mentum of GOMPHIDAE



(fig. 4) ⓑ
SPOON SHAPED MENTUM OF CORDULEGASTER

1 Gills not visible externally, head not wider than thorax and abdomen; dragonfly nymphs looks more like a general insect than an adult dragonfly (fig. 1)
Suborder ANISOPTERA, 2 (p5)

1' Gills consist of three flat external plates at the posterior end of abdomen; damselfly nymphs, looks more like an adult dragonfly than a general insect (fig 2)
Suborder ZYGOPTERA, 47 (p12)

2(1) Labium flat (fig 3) 3

2' Labium spoon shaped, covering lower part of face like a mask as far as the base of the antennae (fig 4) 5

3(2) Antennae 4 segmented; first two pairs of legs with 2 jointed tarsi, true burrowers
GOMPHIDAE, 36 (p10)

3' Antennae 6 or 7 segmented; all legs with 3 jointed tarsi 4

4(3') Antennal segments short, thick, hairy PETALURIDAE, *Tachopteryx thoreyi*

4' Antennal segments slender, bristle-like; climbers AESHNIDAE, 30 (p9)

5(2') Inner edge of lateral lobe of labium coarsely and irregularly toothed, not true burrowers hide under detritus, usually large stream dwellers
CORDULEGASTERIDAE, *Cordulegaster*

5' Inner edge of lateral lobe of labium evenly and regularly toothed, or without teeth, bottom sprawlers, not climbers or burrowers 6

6(5') Frontal projection between bases of antennae, appears as a prominent median horn , very long legs MACROMIIDAE, 7

6' No frontal projection LIBELLULIDAE and CORDULIIDAE, 8 (p6)

7(6) Lateral spines of abdominal segment 9 reach to rearward to level of tips of inferior appendages (paraprocts); Bulging sides of head hardly narrowed between eyes; 3 lateral labial setae, no dorsal hook on segment 10 *Didymops transversa*

7' Lateral spines of segment 9 do not reach rearward to tips of inferior appendages (paraprocts); sides of head somewhat convergent behind eyes to pair of low tubercules on hind angles; 6 lateral labial setae; small dorsal hook on segment 10
Macromia illinoiensis

Key to the genera of the families LIBELLULIDAE and CORDULIIDAE

8(6')	Abdomen with dorsal hooks	9
8'	Abdomen without dorsal hooks	22
9(8)	No lateral spines on segment 8	*Williamsonia*
9'	Lateral spines present on segment 8	10
10(9')	Dorsal hook on abdominal segment 9	11
10'	No dorsal hook on abdominal segment 9	16
11(10')	Lateral spines on segment 8 strongly divergent; crenulations on distal margin of labial palpi nearly semicircular or more deeply cut	*Neurocordulia*
11'	Lateral spines on segment 8 not strongly divergent	12
12(11')	Four lateral labial setae	*Epicordulia* princeps*
12'	Five to seven lateral labial setae	13
13(10')	Six or seven lateral labial setae	14
13'	Five lateral labial setae	13a
13a (12')	Lateral spines on segment 9 reach or surpass tips of anal pyramid	*Epicordulia princeps*
13a'	Lateral spines on segment do not reach tips of anal pyramid	*Perithemis tenera*
14(11')	Lateral spines of segment 9 more than half its middorsal length reach rearward to tips of paraprocts; Dorsal hooks on segments 2 - 9; often cultriform and sharp	*Tetragoneuria**
14'	Lateral spines of segment 9 less than half its middorsal length, Dorsal hooks less developed, but sharp and slender	15
15(12')	Dorsal hooks on segments 2 - 9 laterally flattened but obtuse at apices	*Somatochlora*

* The genera *Tetragoneuria* and *Epicordulia* are called *Epitheca* by some authorities. I tend to be a splitter because it makes identification easier.

15' Dorsal hooks only on segments 5 or 6 to 9, longest on 8, cultriform *Helocordulia uhleri*

16(10') Dorsal hook on segment 8 17

16' No dorsal hook on segment 8, sometimes dorsal hooks can be small and difficult to see, eyes usually patterned *Celithemis*

17(16) Eyes lateral, usually very large in relation to head size (fig.6 above) 18

17' Eyes capping the anterolateral angles of the head, more frontal than lateral, smaller in relation to head size 20

18(17) Broad, dark longitudinal stripe across thorax, 7 lateral labial setae *Dorocordulia*

18' Thorax uniformly colored; nine to fourteen lateral labial setae 19

19(18') Superior abdominal appendage (epiproct) as long as, or nearly as long as inferiors (paraprocts); eyes usually unpatterned *Leucorrhinia*

19' Epiproct much shorter than paraprocts; no dorsal hook on segment 3; eyes usually patterned *Sympetrum*

20(17') Margin of median lobe of labium appearing smooth, under higher magnification, the margin is irregularly jagged *Libellula*

20' Margin of median lobe of labium evenly and regularly crenulate, the margin is scalloped with a setae in each valley 21

21(20') Dorsal hook on segment 8; 0- 3 premental setae *Ladona*

21' No dorsal hook on segment 8; hooks present on segments 3-5 *Plathemis (Libellula) lydia*

22(8') Inferior anal appendages (paraprocts) strongly decurved (curved down) at tip, eyes large and usually patterned (fig 7) *Erythemis simpicicollis*

22' Anal appendages straight or nearly so 23

23(22')	Eyes lateral, usually very large (see illustrations on couplet16)	25
23'	Eyes capping the anterolateral angles of the head, more frontal than lateral, smaller in relation to head size	24
24(23')	Broad, dark longitudinal stripe across thorax	*Cordulia shurtleffi*
24'	Thorax uniformly colored	*Somatochlora*
25(23)	Six or seven lateral labial setae (Length <10mm)	*Nannothemis bella*
25'	Nine to 14 lateral labial setae	26
26(25')	Lateral spines on segment 8 minute or lacking	*Sympetrum corruptum*
26'	Lateral spines present on segment 8	27
27(26')	Lateral spines of segment eight short and nine long	28
27'	Lateral spines of segments eight and nine about equal, brackish waters	*Erythrodiplax berenice*
28(27)	Lateral spines on segment 8 about half as long as on 9	*Pachydiplax longpennis*
28'	Lateral spines at least half as long as those on 9	29
29(27)	Three dark longitudinal stripes on the ventral surface of the abdomen; can be indistinct but always present	*Leucorrhinia*
29'	No such markings; lateral spines on 8 nearly as long as on 9	30
30(29')	Superior abdominal appendage (epiproct) as long as, or longer than inferiors	*Pantala*
30'	Superior abdominal appendage (epiproct) shorter than inferiors	*Tramea*

Key to the genera of the family AESHNIDAE

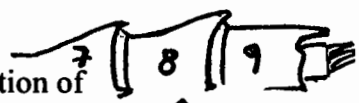
30(4')	Hind angles of head angulate, lateral spines on segments 5-9	31
30'	Hind angles of head rounded (sometimes slightly angulate in *Aeshna eremita*); lateral spines on segments 6 or 7 to 9	34

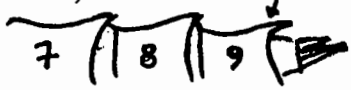
Note: if you cannot tell if the hind angles of the head are sharp or rounded your specimen probably *Aeshna eremita*, which has lateral spines on segments 5-9

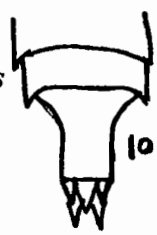
31(30)	Blade of lateral lobe of labium wide and squarely truncated on outer end; white spot on abdominal segment 7	*Boyeria*
31'	Blade of lateral lobe of labium narrowed toward tip and with stronger end hook	32
32(31')	Dorsum of abdomen broadly rounded	*Basiaeschna janata*
32'	Dorsum of abdomen with a low median ridge	33
33(32')	Blunt dorsal hooks on median ridge	*Nasiaeschna pentacantha*
33'	No dorsal hooks on median ridge on posterior half of abdomen	*Epiaeschna heros*
34(30')	Lateral spines on abdominal segments 7 to 9 only	35
34'	Lateral spines on segments 5 or 6 or 7 to 9	*Aeshna*
35(34)	Antennae longer than distance from its base to rear of head	*Gomphaeschna*
35'	Antennae about half as long as this distance	*Anax*

Key to the genera of the family GOMPHIDAE

36(3)	Antennal segment 4 without setae and generally about one fourth as long as large, hairy segment 3; middle legs closer together than fore legs	*Progomphus obscurus*
36'	Antennal segment 4 vestigal or nearly so; Middle legs not closer together than fore legs	37
37(36')	Wing pads strongly divergent; lotic species	*Ophiogomphus*
37'	Wing pads laid parallel along back	38
38(37')	VERY large, flat body; abdomen nearly circular	*Hagenius brevistylus*
38'	Body more elongate and cylindric	39
39(38')	Antennal segment 3 flat, and nearly as wide as long	40
39'	Antennal segment 3 elongate, and more or less cylindric	41
40(39)	Antennal segment 3 widest proximally, inner margins straight and nearly parallel; Frontal shelf truncate apically; Anterior margin of prementum nearly straight and generally with three teeth	*Stylogomphus albistylus*
40'	Antennal segment 3 nearly oval and convex ; frontal shelf bifurcate; anterior margin of prementum convex and generally with 4 teeth	*Lanthus*
41(39')	Dorsal hook on abdominal segment 9 is spine-like abdominal termination of middorsal ridge	*Dromogomphus spinosus*
41'	Dorsal hook on segment 9, if present, rises above level of its rounded dorsum	42
42(41')	Abdomen ends to rearward in a long, tapering point (bottleneck); a low, wide median ridge, but no median groove on middle segments	*Arigomphus*
42'	Abdomen ends to rearward more abruptly; there may be a median groove on middle segments	43
43(42')	Tibial burrowing hooks vestigal or lacking; 1 to 4 palpal teeth, abdomen slender, no wider than head	*Stylurus*
43'	Tibial burrowing hooks well developed, 5 or more palpal teeth; abdomen wider than head	44







44(43')	Abdomen lanceolate (moderately pointed to rearward); small dorsal hooks on middle segments; no median groove	*Gomphus*
44'	Abdomen ending more bluntly , flattened, narrowed abruptly at segment 9; lateral spines of segment 9 spinulose-serrate on outer edge	45
45(44')	Small species: length less than 27 mm	*Hylogomphus*
45'	Larger species: length 28-40 mm	46
46(45')	Lateral spines of abdominal segment nine equal to the middorsal length of segment 10	*Stenogomphurus rogersi*
46'	Lateral spines of abdominal segment nine 1½ times to 2 times the middorsal length of segment 10	*Gomphurus*

Some notes on the identification of damselflies:
Prementum = median lobe
What can/cannot be identified with lost appendages:
No prementum/abdomen/head = cannot be identified
No Caudal lamellae: Rounded posterolateral margins of head, genus id is possible. With angulate posterolateral margins of head, you can identify them using the antennal features only if they are later instars (see introduction for explanation), otherwise identification is not possible. The latter species are uncommon.

Key to the Zygopteran families and genera adapted from Westfall and May (1996) and Walker (1953)

47(1')	First antennal segment longer than the remaining segments combined; stream dwellers	CALOPTERYGIDAE, 48
47'	First antennal segment shorter than the rest combined	49
48(47)	Prementum cleft nearly ½ way to its base; postlateral margins of abdominal segments 9 and 10 without spines	*Calopteryx*
48'	Prementum cleft only to base of palpi; posterolateral margins of segments 9 and 10 with small distinct spines	*Hetaerina*
49(47')	Spoon-shaped mentum with a median, closed cleft, mental base reaching to mesothoracic coxae (fig 5)	LESTIDAE, *Lestes*
49'	Flat mentum lacking a median cleft; mental base not reaching much beyond prothoracic coxae	COENAGRIONIDAE, 50
50(49')	Premental setae absent; palpal lobes with two distal, pointed hooks; palpal setae 0-3 (rarely 4-5); body form usually short and stout; caudal gills about ½ as broad as long	*Argia*
50'	Premental setae present	51
51(50')	Postlateral margins of head distinctly produced and sharply angulate	52
51'	Postlateral margins of head not distinctly produced, broadly rounded	53

52(51) Apices of gills with acute tip long and sharply pointed; gills about one-sixth as broad as long, margins with widely separated setae; antennae 7- segmented *Chromagrion contindum*

52' Apices of gills with tip not so long and acute; gills about one third as broad as long, margins thickly and closely beset with setae; antennae 5-6 segmented *Amphiagrion saucium*

53(51') One premental setae of normal length present, although 1 to 3 small setae may be present on its medial side, 1 long one and some short ones 54

53' At least 2 premental setae of normal length present, 2 or more equal length setae present 55

54(53) Palpal setae 3-4; numerous long, stiff setae present on lateral carinae of all abdominal segments beyond first *Enallagma*

54' Palpal setae 5-6; no long stiff setae present on lateral carinae of anterior abdominal segments, although often present on posterior segments *Nehalennia*

55(54') Eyes usually with a pattern of lateral, alternating pale and dark bands; antennae usually with 7 distinct segments; lateral carinae of abdominal segments 2-7 with numerous small setae not arranged in a single row; caudal lamellae taper to a fine tip *Ischnura*

55' Eyes with no such pattern of lateral pale and dark bands, although dark spots may be apparent; antennae 6 or 7 segmented; lateral carinae of abdominal segments 2-8 usually with a single row of setae of variable stoutness *Coenagrion* and *Enallagma*

(For location of lateral carinae see fig 6)

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