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## NOTES ON THE NESTING HABITS OF SEVERAL NORTH AMERICAN BUMBLEBEES. [1]

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In a comprehensive paper on the bumblebees of Central Europe, Friese and Wagner (1910, p. 69) make the following statement: "Insbesondere lässt die Kenntniss der Nester noch allzuviel zu wünschen übrig, was um so empfindlicher ins Gewicht fällt, als gerade von dieser Seite her die vielleicht wertvollsten Aufschlüsse zu erwarten stehen, weil allen Folgerungen, die lediglich auf einem durch Fang der frei fliegenden Tiere gewonnenen Materiale basieren, notwendigerweise eine gewisse Unsicherheit anhaften muss." The truth of this statement has been amply proved by the work of Drewsen and Schiödte (1838), Smith (1876), Schmiedeknecht (1878), Hoffer (1881, 1882/83, 1885, 1888), Coville (1890), Sladen (1899, 1912, 1915), and Frison (1916, 1917, 1918, 1921).

What Friese and Wagner (p. 69) have to say concerning the Central European bumblebees, is even more true of our American species. Of the 86 New World species of Bremus (Bombus) listed by Franklin (1912/13, 1914) and Frison (1921a), the nesting habits of only 17 have thus far been recorded,[2] but some of these data are so incomplete that they have little or no value. It is the object of this paper to add another species (*Bremus occidentalis* Greene) to those enumerated below and to supplement our knowledge concerning the nesting habits of

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[2]Those of *Bremus affinis*, *auricomus*, *bimaculatus*, *borealis*, *cayennensis*, *emeliæ* (*thoracicus*), *fervidus*, *flavifrons*, *impatiens*, *pennsylvanicus*, *perplexus*, *rufocinctus*, *separatus*, *ternarius*, *terricola*, and *vagans*; by Putman (1865), Coville (1890), Hudson (1892), von Ihering 1903), Franklin (1912/13), Howard (1918), and Frison (1916, 1917, 1918, 1921).

several others. A brief résumé of all that is known of the nesting habits of the 9 species treated in this paper has been added, in order to make these data as complete as possible. The new facts which I have recorded in the following paragraphs are based on observations of 55 bumblebee colonies which were discovered at Berkeley, Calif., Washington, Me., and Boston, Mass., during the summers of 1920, 1921, and 1922, and on copious field notes.

The interesting beetles of the genus Antherophagus, and also mites of the family Gamasidæ, occurred in almost every one of the 50 nests which I examined, and in one case over 20 of the beetles were found; but, to avoid useless repetition, the individual cases are not cited below.

## Terrestris Group.

### I. *Bremus affinis* Cresson.

Very little is known concerning the nesting habits of this bee. Some years ago, Franklin (1912/13, I, p. 280) found a nest in southern Vermont during the early part of July. It was situated in an open mowing place on the surface of the ground, and, since it contained but a few cells with partially developed larvæ, had apparently been started only shortly before by the queen. Franklin (p. 280) makes the following statement regarding the location of this nest: "Although this was a surface nest, the fact that the queens of this species are never seen in abundance, while the workers and males in late summer often appear in large numbers, together with the fact that their nests are so seldom found, leads me to the opinion that they are usually subterranean."

The surmise expressed in the forgoing quotation is confirmed by my own observations. Of 9 *Bremus affinis* nests discovered in the Arnold Arboretum (within the city limits of Boston) during the summers of 1921 and 1922, every one was subterranean. They were situated from 1 to 4 ft. below the surface of the ground and had tunnels varying from 18 inches to 8 ft. in length. The

largest colony was taken on September 1, 1922. It contained the old queen, 19 young queens, 27 males, and over 175 workers.

Not long ago, Bequaert (1920) described a new variety of *Bremus affinis* which he called *novæ-angliæ*. This variety occurred in 2 of the 8 nests mentioned above. The first of these was taken July 11, 1922. It contained (1) the old queen, 1 young queen, and 43 workers of *Bremus affinis*; (2) 12 workers of *Bremus affinis* var. *novæ-angliæ*; and (3) 1 worker of *Bremus terricola* Kirby. The second nest was taken August 4, 1922. In it were found (1) 23 workers of *Bremus affinis*; (2) 9 workers of *Bremus affinis* var. *novæ-angliæ*; and (3) 1 worker of *Bremus terricola*. The contents of these two nests, and the character of the bees reared from the second, suggest that *Bremus affinis* var. *novæ-angliæ* Bequaert is a hybrid between *Bremus affinis* and *Bremus terricola*, a question which will be discussed in another paper.

Two other of the 8 *Bremus affinis* nests were victimized by *Psithyrus ashtoni* Cresson. One of these, on August 9, 1921, contained (1) the old queen and about 100 workers of *Bremus affinis*; and (2) the old queen, 3 young queens, and 6 males of *Psithyrus ashtoni*. A detailed account of the subsequent history of this *affinis-ashtoni* colony has appeared in another paper (1922). The second colony parasitized by *Psithyrus ashtoni* was taken on July 26, 1922. It contained (1) the old queen and about 20 workers of *Bremus affinis*; and (2) the old queen (dead), 2 young queens, and 2 males of *Psithyrus ashtoni*. During the following weeks several more young Psithyrus queens and males were obtained from this colony.

*Bremus affinis* frequently stores a considerable quantity of pollen in long, waxen cells, which Hoffer (1882/83, II. pp. 85, 86) called pollen cylinders. I noticed a number of these pollen cylinders in 2 of the 8 *Bremus affinis* colonies. Both of these colonies were rather large, each one having over 150 workers. In one of these two nests most of the pollen cylinders were from 5 to 6 cm. long, and the total pollen contained in them weighed about 2 ounces.

The queen of *Bremus affinis* is colored differently than the workers and males, and for a time it seemed doubtful whether the two groups belonged together (cf. Franklin 1912/13, I, p. 280). My observations confirm the conclusions of Bridwell and Franklin.

In the vicinity of Boston, the queens of *Bremus affinis* leave their winter quarters toward the end of April, and most colonies are probably started in May. The workers begin to appear toward the end of May, and the young queens and males are largely produced in August and September. The more prosperous nests do not break up until October.

*Bremus affinis* is gentle as compared with such species as *Bremus fervidus* and *Bremus impatiens*. When one disturbs their nest, the foraging workers, as a rule, immediately fly away as soon as they notice the intruder.

II. *Bremus occidentalis* Greene.

There seems to be no record (cf. Franklin 1912/13, I, p. 273) that a nest of *Bremus occidentalis* has ever been taken. I accidentally discovered 2 nests of this species at Berkeley, Calif. during the summer of 1920, both of which were subterranean. One of these was about 2 ft. below the surface of the ground, and contained (July 12th) 5 young queens and over 80 workers. This colony was transferred to an observation box, but soon afterwards was destroyed by Argentine ants (*Iridomyrmex humilis* Mayr). The other colony was not dug up.

*Bremus occidentalis* is similar in disposition to *Bremus affinis*.

III. *Bremus terricola* Kirby.

Practically nothing is known concerning the nesting habits of this species. Coville (1890) probably took a colony near Ithaca, N. Y. during the summer of 1885, but he only briefly refers to its egg-laying habits.

I took a nest of this species near the Arnold Arboretum on July 3, 1922, and about two weeks later another nest was taken by Dr. E. S. Anderson, at Washington, Me. The nest which I took was situated 9 inches below the surface of the ground with

a tunnel 1 ft. long; the other, according to Dr. Anderson, was about 3 ft. below the surface, and had a tunnel 21 ft. long. The nest taken near the Arnold Arboretum contained (1) 9 young queens and about 60 workers of *Bremus terricola*; and (2) the well-preserved bodies of a *Bremus impatiens* and a Psithyrus queen belonging to the Laboriosus Group. In the other, Dr. Anderson found (1) the old queen and about 125 workers of *Bremus terricola:* and (2) numerous pseudo-scorpions.

In the vicinity of Boston, *Bremus terricola* is the first bumblebee to appear in spring. In 1922 several queens were seen on willow as early as April 13th. Most colonies are probably started between the 15th of April and the 15th of May. The workers begin to appear shortly after the middle of May, and most of the young queens and males are produced in July and August. I have never seen any workers after September 1st.

The workers of *Bremus terricola* are somewhat more vicious than those of *Bremus affinis*.

## Borealis Group.

I. *Bremus borealis* Kirby.

Coville (1890, pp. 198,201) records taking a nest of this species in July 1885 near Ithaca, N. Y. It contained "the queen and a large number of workers," but nothing is said as to whether the nest was situated on, or below, the surface of the ground.

On July 8, 1922, I noticed a *Bremus borealis* queen searching for her nest among the mowed grass near a stump, about a mile from the Arnold Arboretum. She was carrying a big load of pollen and repeatedly arose into the air to take her bearings. Whenever she alighted, she hurriedly crept about among the grass, at times frantically shaking her wings. I removed all the cut grass within a radius of about 10 ft. of the stump, but even then she was unable to find her nest. Fearing that she might desert the place, I captured and used her for breeding experiments which will be described in a separate paper. Although I searched carefully near the stump, no surface nest

could be found, and it is therefore probable that this nest was subterranean.

In the neighborhood of Boston, *Bremus borealis* is extremely rare. Most of the queens probably do not appear until late in spring. Three other queens which I captured in 1922 were taken May 29th (on Diervilla), June 6th (on Rhododendron), and July 2nd (searching for a nesting site). However I have never seen any workers or males of this species near Boston.

## Pratorum Group.

I. *Bremus bimaculatus* Cresson.

The only nest of *Bremus bimaculatus* of which we have a record was taken by Franklin (1912/13, I, p. 308) on July 15, 1904, at Bernardstown, Mass. It was situated on the surface of the ground, among the bases of saplings, in a thicket of alders, and contained 6 queens, 10 workers, 9 males and a considerable number of cells with partially developed larvæ.

I found 4 nests of this species in, or near, the Arnold Arboretum during the summers of 1921 and 1922. All were subterranean, and from 6 inches to 1 ft. below the surface of the ground, the tunnels varying from 9 inches to 4 ft. in length. One of the shorter-tunneled nests, taken July 3, 1921, was almost completely destroyed by the larvæ of the tachinid fly, *Brachycoma sarcophagina* Townsend (det. Mr. C. W. Johnson). This nest also contained several thief ants (*Solenopsis molesta* Say (det. Dr. G. C. Wheeler). The largest of the 4 nests contained (July 8, 1921) the old queen, 23 young queens, over 60 workers, and a considerable number of queen cells.

In the vicinity of Boston, the queens of *Bremus bimaculatus* appear at about the same time as those of *Bremus terricola, i. e.* during the latter half of April. Most colonies are probably started in May. Like *Bremus pratorum* in Europe, *Bremus bimaculatus* completes its life-cycle very early. The workers begin to appear in considerable numbers toward the end of May, while most of the young queens and males are produced in June and July. The nests break up in August.

Franklin (1912/13, I, p. 309) says that the workers of this species are "very waspish," a statement which is corroborated by my experiences.

II. *Bremus impatiens* Cresson.

Putnam (1865, p. 101) reports taking a nest of this species under an old stump, in an orchard, but gives no further details, while Franklin (1912/13, I, p. 313) has the following to say concerning the nesting habits of this bumblebee: "I have taken several nests of this species and have known of their being taken by others and, as far as I have been able to ascertain, they are invariably subterranean and the colonies often consist of a very large number of individuals." On August 31, 1904, the same author took a nest of *Bremus impatiens*, at Amherst, Mass. It was about 2½ ft. below the surface of the ground and contained 4 queens, 15 males, 321 workers, and 330 unbroken cells, 154 of which were queen cells.

I took 16 nests of this species during the summers of 1921 and 1922. Of these 16 nests, 11 were discovered in, and 5 near, the Arnold Arboretum, one of the latter being taken on the grounds of the Bussey Institution. All of these 16 nests, as well as several others which were not dug up, were subterranean. They were from 1 to 3 ft. below the surface, and had tunnels varying from 18 inches to 5 ft. in length. A number of these nests were situated in decayed stumps. Most of the colonies were very populous, the largest one consisting of over 450 workers (August 4, 1921). Five of the nests taken during the early part of the summer contained, in addition to the queen which "ruled" the nest, from 1 to 4 dead *impatiens* queens.

One of the 16 colonies was parasitized by a Psithyrus belonging to the Laboriosus Group. This nest, on August 8, 1922, contained (1) 17 males and about 75 workers of *Bremus impatiens*, as well as the well-preserved body of the old queen; and (2) the old queen and 2 males of Psithyrus. During the next few weeks, a considerable number of Bremus and Psithyrus males, and several Psithyrus females, were reared from this Bremus-Psithyrus colony.

Another of the 16 nests which was taken on September 11, 1922, contained (1) 31 males and about 50 workers of *Bremus impatiens*; (2) many adults and larvæ of Antherophagus; (3) a large number of spiny, dipterous larvæ (probably those of Fannia); and (4) numerous pseudo-scorpions (*Chelanops sanborni* Hagen (det. Mr. Nathan Banks). A few of these pseudo-scorpions were also found in one of the *affinis* nests. Mr. Nathan Banks has informed me that *Chelanops sanborni* is frequently found attached to the appendages of insects, especially those of Diptera. This fact, together with the fact that all 3 nests in which these pseudo-scorpions occurred, were at least 3 ft. below the surface of the ground, and had exceptionally long tunnels, suggests that Chelanops, like the beetles of the genus Antherophagus, gets into bumblebee nests by phoresy (cf. Wheeler, 1919).

Franklin (1912/13, I, p. 313) states that in the large nest of *Bremus impatiens* taken by him, the majority of the cells seemed to be entirely separate from one another. This was the case with most of the 8 *Bremus affinis* nests which I took, but it was not true of any of the 16 *impatiens* nests.

In addition to the main tunnel, which was about 1¼ inches in diameter, 3 of the most populous nests also had a narrower tunnel, about ½ inch in diameter, leading to the nest from the side opposite the main tunnel. Through this narrow tunnel, probably made by the bees themselves, nesting material was dragged in. In Europe, Wagner (1907, p. 11) found a similar narrow, secondary tunnel in connection with a nest of *Bremus lapidarius*, and concluded that it was constructed by the queen. However it seems more likely that this passage, if made by the bees, is excavated by the workers, and that it probably also serves as a ventilating shaft, for *Bremus lapidarius*, like *Bremus impatiens*, frequently has very populous colonies.

A prosperous *Bremus impatiens* colony stores a considerable quantity of honey and pollen. The latter, as in the case of *Bremus affinis*, is sometimes stored in pollen cylinders.

In the vicinity of Boston, the queens of *Bremus impatiens* appear in large numbers in May, and most colonies are probably

started between the middle of May and the middle of June. The workers begin to appear about the first week of June, and the majority of the young queens and males hatch in August and September. The workers may be seen foraging as late as October.

*Bremus impatiens* is one of the more vicious species.

III. *Bremus vagans* Smith.

A nest of this species was discovered by Putnam (1865, p. 98) in 1862 at Warwick, Mass., but it is not clear from his description, whether it was situated in an old stump or under a pile of stones. A nest taken by Beutenmüller (cf. Franklin, 1912/13, I, p. 354), at Potato Knob, North Carolina (elevation 6,420 ft.), about July 1, 1902, was situated in a hollow tree, and contained 2 queens and 8 workers, but several individuals escaped. A third nest, taken by Franklin (1912/13, I, p. 354) July 20, 1904, on the surface of the ground, contained 2 queens, 2 males, and 8 workers.

I took 6 nests of this species in, or near, the Arnold Arboretum during the summers of 1921 and 1922. Two of these were surface nests, while the remaining 4 were subterranean. The latter were all about a foot below the surface of the ground and had tunnels varying from 1 to 5 ft. in length. The largest nest contained (August 2, 1921) the old queen, over 70 workers, and a considerable quantity of brood. This colony, as has been stated in another paper (1922), was later victimized by a Psithyrus.

In addition to the nest just mentioned, 2 others were parasitized by Psithyri. One of these was taken June 26, 1922. It contained (1) the old queen and about 40 workers of *Bremus vagans*; and (2) a Psithyrus queen belonging to the Laboriosus Group. The other, taken July 20, 1922, consisted of (1) the old queen and 6 workers of *Bremus vagans*; and (2) a Psithyrus queen belonging to the Laborisous Group. From one of these two colonies a considerable number of Psithyrus males and several Psithyrus females were reared which are different from those obtained from the *Bremus impatiens* nest referred to above.

The taxonomic position of these Psithyri will be dealt with in another paper.

In the vicinity of Boston, the queens of *Bremus vagans* appear comparatively late. In 1922, the first ones were seen on May 15th, on barberry and apple blossoms. Most nests are probably started between the 15th of May and the 15th of June. The workers begin to appear about the 1st of June, while the young queens and males are produced chiefly during August. The colonies break up in September.

Franklin (1912/13, I, pp. 348, 354) states that *Bremus vagans* is exceedingly ferocious, and that the workers of the nest taken by him were the most vicious and ready to sting of any with which he has had experience. This was not true of the 6 colonies taken by me, the workers of all of these colonies being rather gentle as compared with those of such species as *Bremus fervidus* and *Bremus impatiens*.

### Dumoucheli Group.

I. *Bremus fervidus* Fabricius.

Both Putnam (1865) and Franklin (1912/13, I, p. 393) have taken a large number of nests belonging to this species. Putnam found them on the surface of the ground, under boards, piles of stones, the flooring of a shed, and in stumps, while the nests taken by Franklin were all surface nests. The largest nest taken by Putnam (July 23, 1863, at Bridport, Vt.) contained about 70 adult bees, 150 cocoons, and 200 larvæ. Of the two largest colonies reported by Franklin, one, taken July 22nd, consisted of 1 queen, 2 males, 30 workers, and 125 unbroken cells; the other, taken September 7th, 7 queens, 3 males, and 37 workers.

I took 13 nests of this species in, or near, the Arnold Arboretum during the summers 1921 and 1922, one of the nests being situated on the grounds of the Bussey Institution. Another nest of this species was taken (August 1922) at Washington, Me., by Dr. E. S. Anderson, who was kind enough to turn the

colony over to me for observation. Of these 14 nests, 1 was situated 2 ft. above ground, in a stone wall, 4 were surface nests, and the remaining 9 were subterranean. These latter were from $\frac{1}{2}$ to 1 ft. below the surface of the ground and had tunnels varying from $\frac{1}{2}$ to 2 ft. in length. As in the case of *Bremus impatiens*, several of the nests taken during the early part of the summer contained one or more dead *fervidus* queens besides the one living.

Franklin (1912/13, I, p. 393) states that the nests of *Bremus fervidus* never contain a large number of bees, the largest nest taken by him consisting of 47 individuals, of which 37 were workers. However this is not always the case. Of the 13 nests which I took, 3 consisted of from 100 to 125 workers each, and this despite the fact that one of them was taken comparatively early in the season (July 18, 1922). Each one of these 3 colonies later produced more workers and more than a hundred males and young queens.

Of the 14 nests, one contained 22 large, dipterous larvæ which, judging by Sladen's (1912, p. 74) figure, were probably those of Volucella. Attempts to rear the larvæ proved unsuccessful.

When the first large *Bremus fervidus* nest was discovered during the summer of 1921, I at first thought I was dealing with a surface nest, for a large quantity of nesting material which contained about a dozen workers, covered the opening of the tunnel. This was also the case with 2 populous, subterranean nests of this species which I took during the summer of 1922. In Europe, Hoffer (1882/83, II, pp. 35, 36), Härter (1890, p. 74), and Bachmann (1915, p. 76), each found a similar "Vornest" or "Scheinnest" in connection with the nests of *Bremus pomorum*. The only plausible explanation for these "pseudo-nests" seems to be that more nesting material is gathered by the colony than the nest cavity can hold.

In the vicinity of Boston, the queens of *Bremus fervidus* appear in large numbers during the latter half of May. In 1922 the first one was seen on May 7th. Most nests are probably started between the middle of May and the middle of June.

The workers begin to appear about the 1st of June, while the males and young queens are chiefly produced in August and September. The colonies, like those of *Bremus impatiens*, do not break up until October.

On page 99, Putnam (1865) makes the following statement concerning *Bremus fervidus:* "This.....species.....is of quite a gentle disposition, allowing its nests to be disturbed for some time before it makes any show of resistance, merely exhibiting its uneasiness by buzzing." I cannot subscribe to this statement. Of all the species with which I have had experience—including *Bremus terrestris, lapidarius, agrorum, muscorum, sylvarum,* and *helferanus* in Europe—, *Bremus fervidus* is by far the most vicious. Usually, when its nests are disturbed, one or more workers at once pounce on the intruder and punish him. If he takes to his heels, they sometimes follow him for a hundred yards or more. I was stung severely by this species on several occasions.

*Bremus fervidus*, as I have pointed out recently (1922a), has the interesting habit of expelling the queens and workers of other Bremidæ from its nests by daubing them with honey.

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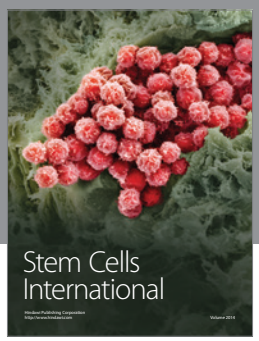

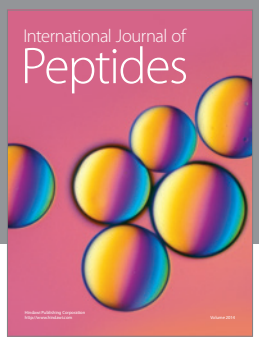

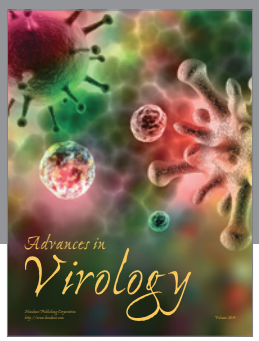

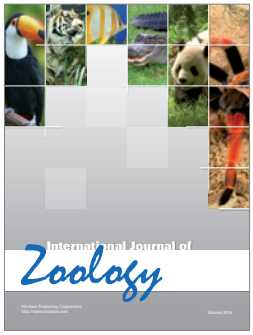

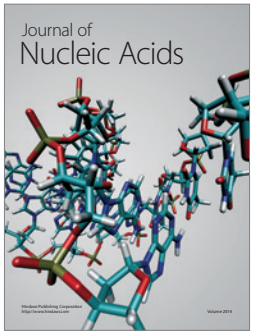

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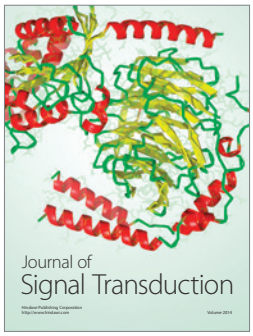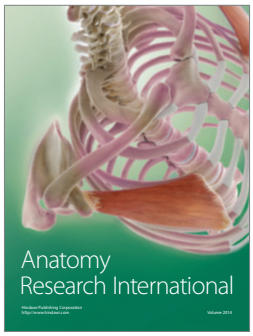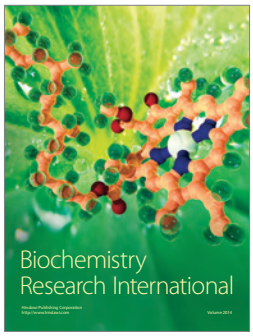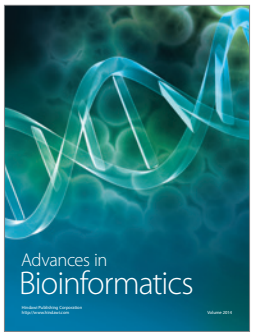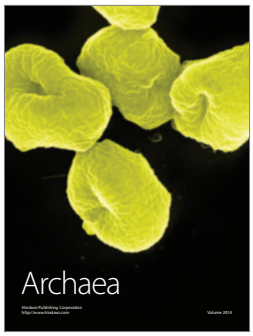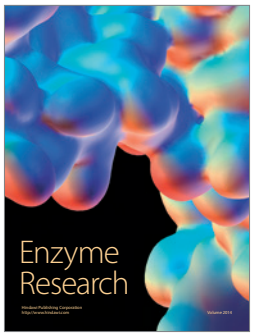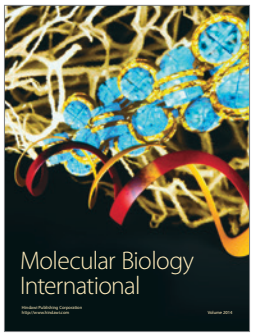
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