FLOWER-VISITING INSECTS AND PROBABLE POLLINATORS OF SOME DIPLOID AND POLYPLOID SPECIES OF POTENTILLA

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INTRODUCTION

The environment of a flowering plant includes among others a genetic component and a entomological one. Since it is well known that perhaps 40-50% of all angiosperms have chromosome numbers indicating that they are of polyploid origin (Stebbins, 1947), polyploid species and their diploid relatives are not uncommon and yet are distinct enough to ask how such complicated genetic arrangements arose. This paper attempts to demonstrate that associated with a distinct set of diploid and polyploid species is a distinct correlated set of flower-visiting insects, among which are the actual pollinators. In other words, I have tried to correlate unique pollinators with different closely related species of the same genus, many of which are polyploids.

The effect of polyploidy on a plant is sometimes evident in the general habit or appearance of the plant, or it may be detected by gigantism of various sorts -- cytological or in other features. One of these other features is the absolute concentration of various compounds, including defensive ones such as phenolics (Levin, 1971). Some of these types of compounds may be considerably increased in concentration in a polyploid condition and hence may be responsible for the preferential survival of that genetic combination. That concept was the original stimulus for this paper, but I was unable to find a well-segregated polyploid species complex in our flora which was known to possess such compounds. So I have concentrated on studying whether local polyploid Potentilla species have characteristic flower-visiting insects.

MATERIALS AND METHODS

Of the ten known local species of _Potentilla_ I have observed 6. These six, along with their chromosomal situations, are listed in Table 1. I did not find _P. simplex_ (chromosome number unknown) nor _P. intermedia_ (chromosome number = 56, or 8x) which is probably a hybrid between _P. argentea_ and _P. recta_ (personal communication from Dr. Voss). _P. palustris_, a red-flowered bog or wet area species, was already principally past flowering by the time this project got under way, and I did not take the time to go observe white-flowered _P. tridentata_ (in the jack pine plains to the south).

I found _P. norvegica_ only in a roadside ditch near Cheboygan State Park and only one plant of _P. arguta_ in the park itself. I also observed _P. fruticosa_ in the park. I traveled to an old field just west of I75 and north of Riggsville road to observe _P. recta_, and to the north shore of Burt Lake for _P. anserina_. _P. arguta_ carpets the U.M.B.S. ball diamond, and that's where I observed it.

I spent three hours observing the flowers of _P. argentea_, _P. anserina_, and _P. fruticosa_ each, 2½ hours on _P. recta_, and 1½hours on _P. norvegica_ and _P. arguta_ each. All these observations were done on warm sunny afternoons, ½ hour on a species at a time. I estimate the number of flowers observed for each species to be as follows: _P. anserina_ -- 10 (the first session), and 35-50 (the remaining 5 sessions); _P. argentea_ -- 75 (the first 3 sessions), and 300 (the remaining 3 sessions); _P. arguta_ -- only 1 flower at any 1 session; _P. fruticosa_ -- 150; _P. norvegica_ -- 15-25; and _P. recta_ -- 125 (the first 4 sessions), and 11 (the last session).

I tried to collect every insect I saw visiting the flowers of the various species. Some I ignored, such as a grasshopper merely resting on a flower and obviously not searching for anything. After pinning and preserving, I keyed all individuals to family and sorted them together by morphotype. Finally, I pooled and correlated all the morphotypes together from the various species of Potentilla that they were seen on.

In order to suggest that any one or several of the insects collected was probably serving as the pollinator, I would have to demonstrate that it indeed carried the pollen from anther to stigma. To approach this problem, I have tried comparing fresh pollen from P. anserina with pollen I scraped off the leg of a Halictidae # 2 collected on P. anserina. They appeared identical to me, but because of my inexperience in palynology, I discontinued this.

RESULTS

The actual number of insects collected and their proportional abuncance (p_i) are listed by family in Table 2 (a number behind a family name indicates a different morphotype species). I then used this proportional abundance data to calculate an index of species diversity for each Potentilla species using the formula $H = -\sum_{i=1}^{n} p_i(\log_2 p_i)$ This index, as well as the total number of insect species seen visiting the flowers of each Potentilla species, are given in Table 3. Finally, I calculated an index of similarity for every pair of Potentilla species using the formula $S = 2c/a+b$, and this information is given in Figure 1.

DISCUSSION

The diversity of the flower-visiting insects is impressive, judging from the values of H, and yet, in spite of all this diversity, there is not that much overlap in the morphotypes, as evidenced in Figure 1. The most nearly-related samples are those from P. recta and *P. norvegica* and these shared only 4 of 17 total species. The average index of similarity = .272. I think this suggests that each species of *Potentilla* does have a characteristic flower-visiting insect fauna..

But as to which of these flower-visiting insects are the pollinators is another matter. Certainly the Hymenoptera are most important in this respect, and particularly from my observations, Halictidae 1-4, Apidae 1, and Megachilidae 1. All of these carried plentiful pollen when caught. Others probably less important are the other halictids, the ants, and possibly Miridae 1, the butterfly, and Phalacridae 1. I carefully observed these last-named beetles crawling up and down successive filaments of *P. fruticosa*, spending much time apparently feeding on the pollen itself. The dead specimens had much pollen around their mouthparts and head. All this may or may not indicate that the various *Potentilla* species have distinctive pollinators. But I think it certainly illustrates that there are distinctive sets of flower-visiting insects. In fact, only one morpho-species is common to all the *Potentilla* species.

Another consideration is that the general habitat conditions of the plants may be more responsible for the distinctiveness in the visiting insect fauna than the fact that some of them are polyploids. I could have transplanted all six species to a common place and observed the visiting insects, but I feared survival of the plants themselves would have been low. All six species do seem to occupy early successional stage areas, typically with a coarse, sandy soil, and high irradiation. That much they do have in common. I don't think that I can speculate on the coincidence of moisture requirements. But any differences in habitat are, I think, balanced in part by the differences in the flowers themselves, superficially in size, and probably physiologically also in the amount of nectar secreted or pollen produced. These factors would have to be checked. I think it is an open question as to whether or not the visiting insect fauna distinctiveness is due to habitat differences or due to the phenotypic expression as dictated by the genotype of the plant.

The matter is made more complicated by the occurrence of apomixis, or seed production without fertilization. In P. argentea apomixis is only partial -- sexual reproduction may also occur. In those cases where it does not occur, pollination is necessary for development to begin, but the egg cell is not fertilized.(Proctor and Yeo, 1972). This is the only known Potentilla species which definitely can and does reproduce apomictically. (Perhaps this complex partial apomixis is responsible for the highly variable chromosome numbers in P. argentea). Apomixis and polyploidy are very often associated with each other(Stebbins and Babcock, 1939) and this fact would probably invalidate any seed set tests performed to check the effectiveness of certain insects as pollinators on various polyploid flowering plants. This fact probably also means that some of the other Potentilla polyploid species are also apomictic or partially so.

In conclusion, this study is only a beginning to an understanding of how insects and plants interact during their populational life-time. I think this study shows that a set of closely-related polyploid species do have characteristic flower-visiting insect fauna which may also be characteristic pollinators. But many more observations would have to be made to substantiate this latter claim, for overlap in the visiting insects does occur. If there were characteristic pollinators, this might be a fascinating example of coevolution in insects and plants.

Table 1. *Potentilla* species observed and their chromosome status.

Species	Probable chromosome number and ploidy level
Potentilla anserina	28 - 4x or tetraploid
Potentilla argentea	very inconsistent
Potentilla arguta	14 - 2x or diploid
Potentilla fruticosa	14 - 2x or diploid
Potentilla norvegica	70 - 10x or decaploid
Potentilla recta	42 - 6x or hexaploid

Table 2. Numbers of flower-visiting insects to the various *Potentilla* species and their proportional abundance.

Insect	*P. argentea*		*P. anserina*		*P. recta*		*P. fruticosa*		*P. norvegica*		*P. arguta*	
	No.	p_i	No.	p_i	No.	p_i	No.	p_i	No.	p_i	No.	p_i
Bombyliidae 1	9	.102										
Bombyliidae 2	8	.091	1	.015								
Bombyliidae 3	6	.068										
Bombyliidae 4			2	.029								
Syrphidae 1	1	.011	1	.015					1	.1		
Syrphidae 2	17	.193	25	.368	36	.554	14	.125	3	.3	1	1.0
Syrphidae 3	1	.011										
Syrphidae 4			5	.074								
Syrphidae 5			1	.015								
Syrphidae 6							1	.009				
Sarcophagidae 1	2	.023										
Stratiomyidae 1			1	.015								
Muscidae 1							1	.009				
Sciaridae 1							30	.268				
Tachinidae 1							1	.009				
Halictidae 1	10	.114			1	.015						
Halictidae 2	5	.057	16	.235	13	.200						
Halictidae 3	4	.046			2	.031	1	.009	1	.1		
Halictidae 4			9	.132	3	.046	1	.009	4	.4		
Halictidae 5			1	.015								
Halictidae 6			4	.059								
Halictidae 7					1	.015			1	.1		
Halictidae 8					4	.062						
Halictidae 9							5	.045				
Tiphiidae 1	4	.046										
Formicidae 1	12	.136	1	.015	1	.015						
Apidae 1	4	.046			1	.015						
Megachilidae 1					1	.015						
Pompilidae 1					1	.015						
Sphecidae 1	4	.046										
Mordellidae 1	1	.011										
Curculionidae 1							1	.009				
Phalacridae 1							17	.152				
Lampyridae 1							1	.009				
Coccinellidae 1			1	.015								
Miridae 1					1	.015	31	.277				
Hesperiidae 1							8	.071				
Total	88		68		65		112		10		1	

Table 3. Diversity of flower-visiting insects for each species of *Potentilla*.

Insect	*P. argentea* $(p_i)(\log_2 p_i)$	*P. anserina* $(p_i)(\log_2 p_i)$	*P. recta* $(p_i)(\log_2 p_i)$	*P. fruticosa* $(p_i)(\log_2 p_i)$	*P. norvegica* $(p_i)(\log_2 p_i)$	*P. arguta* $(p_i)(\log_2 p_i)$
Bombyliidae 1	.336					
Bombyliidae 2	.314	.091				
Bombyliidae 3	.264					
Bombyliidae 4		.148				
Syrphidae 1	.072	.091			.332	
Syrphidae 2	.458	.531	.472	.375	.521	.000
Syrphidae 3	.072					
Syrphidae 4		.278				
Syrphidae 5		.091				
Syrphidae 6				.061		
Sarcophagidae 1	.125					
Stratiomyidae 1		.091				
Muscidae 1				.061		
Sciaridae 1				.509		
Tachinidae 1				.061		
Halictidae 1	.357		.091			
Halictidae 2	.235	.491	.464			
Halictidae 3	.204		.155	.061	.332	
Halictidae 4		.386	.204	.061	.529	
Halictdiae 5		.091				
Halictidae 6		.241				
Halictidae 7			.091		.332	
Halictidae 8			.249			
Halictdiae 9				.201		
Tiphiidae 1	.204					
Formicidae 1	.392	.091	.091			
Apidae 1	.204		.091			
Megachilidae 1			.091			
Pompilidae 1			.091			
Sphecidae 1	.204					
Mordellidae 1	.072					
Curculionidae 1				.061		
Phalacridae 1				.413		
Lampyridae 1				.061		
Coccinellidae 1		.091				
Miridae 1			.091	.513		
Hesperiidae 1				.271		
H =	3.512	2.71	2.18	2.71	2.05	0.0
No. of species=	15	13	12	13	5	1

Figure 1. A comparison of the indices of similarity between the species of *Potentilla* with respect to their flower-visiting insects.

	P. argentea	*P. anserina*	*P. recta*	*P. fruticosa*	*P. norvegica*	*P. arguta*
P. argentea						
P. anserina	.357					
P. recta	.444	.320				
P. fruticosa	.143	.154	.320			
P. norvegica	.300	.333	.471	.333		
P. arguta	.125	.143	.154	.143	.333	

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