DISCUSSION

Herbert W. Ludwig.[1] *Viability of lice feeding on blood of nonspecific hosts.* Lice are ectoparasites of mammals. They feed exclusively on the blood of their host. Nearly all of the approximately 450 known species are confined to their specific host species. This restriction of a parasite species to a single host species is called host-specificity.

It is obviously of advantage for a parasite to be host-specific because it allows a very close mutual adaptation between parasite and host. It is often assumed that among the causes of host-specificity in Anoplura, the incompatibility of "nonspecific" blood plays a major part. Thus Fahrenholz (*3*) stated somewhat pathetically in 1920: "Lice coming onto a wrong host are devoted to death." Meanwhile, we know that this is at least not always true. We know today that host-specificity is not only and not always caused by the incompatibility of nonspecific blood, but also depends on a wide variety of morphologic, physiologic, etiologic, and other components.

Culpepper (*2*) in 1948 succeeded in rearing the body louse (*Pediculus humanus humanus*) permanently on selected rabbits. In 1968 Ludwig and Thiemes (*7*) could rear the hog louse (*Haematopinus suis*) and the closely related louse of the wild boar (*H. apri*) without restriction on white laboratory mice.

On the other hand, it was reported by several investigators (*1, 6*) that body lice fed on guinea pigs will invariably die within 24 to 30 hours.

A lot of scattered, incomplete, and sometimes also inaccurate work was done in feeding different species of lice on nonspecific host species, but comprehensive and comparative investigations have been missing up to now.

There are two possible ways to examine the effect of nonspecific blood on a given species of sucking lice: the blood may either be offered in a special feeding apparatus in which the lice have to pierce a membrane, or the lice may suck the blood directly from the nonspecific host if suitable arrangements are provided to keep them on its skin.

The first method can be used without major technical difficulties, although there is the problem of preserving the circulating warm blood in the apparatus in a physiologically proper state over a longer period of time. On the other hand, feeding through a membrane makes it possible to feed different blood fractions. By means of this method Häfner and Ludwig (*5*) were able to demonstrate that lice do not reject certain kinds of blood. The hog lice used in these experiments readily accepted the blood of different mammals, distilled water, aqueous dye solutions, and physiologic salt solutions.

The second method was worked out by my coworker Geissel (*4*) and studied on both the hog louse and the body louse. The results for the hog louse are given in Tables 1 and 2, and those for the body louse in Tables 3 and 4.

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Table 1. Rate of survival of 100 female and 75 male adult *Haematopinus suis* of random age distribution while fed on nonspecific hosts.[a]

Time (days)	Host											
	Mouse		Hamster		Rat		Guinea pig		Chicken		Pigeon	
	F	M	F	M	F	M	F	M	F	M	F	M
0	100	75	100	75	100	75	100	75	100	75	100	75
1	94	71	80	64	91	65	3	3	62	55	62	43
2	93	71	74	64	71	53	—	—	48	42	43	28
3	92	66	66	58	52	44			40	39	26	14
4	89	60	52	53	37	34			31	19	7	6
5	83	56	39	44	14	28			26	15	—	1
6	78	56	32	38	8	13			17	11		—
7	69	52	29	35	4	6			12	5		
8	61	51	19	34	3	2			6	2		
9	52.	49	17	31	1	—			1	1		
10	47	39	12	26	—				—	—		
11	44	36	8	22								
12	33	32	2	19								
13	28	25	1	18								
14	26	22	—	16								
15	19	19		13								
16	16	18		7								
17	9	16		5								
18	5	15		1								
19	3	9		1								
20	1	4		1								
21	1	4		—								
22	—	3										
23		2										
24		2										
25		1										
26		1										
27		—										

[a] Each vertical column summarizes the results of five separate tests.
Note: F—Female, M—Male.

Let us first consider the results obtained with *H. suis*, for which the white laboratory mouse can be used as a perfect substitute host. (Suitability as a substitute host here always means suitability of the host's blood as substitute food.) After selection of a suitable host strain and a proper louse population, the hamster may also become a perfect substitute host. It may be noted that the nonmammalian chicken and pigeon proved to be better substitute hosts than the guinea pig and about as good as the rat.

A very similar order of suitability was found for *P. h. humanus:* hamster, mouse, pig, chicken, pigeon, rat, and—last of all again, guinea pig.

Tests with freshly hatched, previously unfed first nymphal stages of the hog louse and body louse generally showed the same pattern in order of suitability as that for adults. The nymphs, however, were considerably more sensitive to the blood of nonspecific hosts than the adult lice. This phenomenon was surprising because we had assumed initially that the compatibility of nonspecific blood was negatively influenced by nutrition with the specific blood earlier in the louse's development. Obviously, quite the contrary is true.

Table 2. Rate of survival of first nymphal stage of *Haematopinus suis*, while fed on nonspecific hosts.

Time (days)	Host			
	Hamster	Guinea pig	Chicken	Pigeon
0	80	100	100	100
1	79	—	74	67
2	69	Nymph 1	45	33
3	62		27	14
4	57		23	—
5	49		10	
6	45	Nymph 2	3	
7	41		—	
8	34			
9	20			
10	17	Nymph 3		
11	17			
12	16			
13	16			
14	16			
15	16			
16	16			
17	16			
18	13			
19	12			
20	11			
21	8	Adult		
22	8			
23	8			
24	5			
25	5			
26	5			
27	5			
28	3			
29	1			
30	—			

These tests, performed with two species of Anoplura, showed that the systematic relationship of the hosts is in no manner indicative of the suitability as a substitute host. This is supported by the fact that the rat and mouse, both belonging to the subfamily Murinae, qualify quite differently as substitute hosts for the body louse and the hog louse. The blood of the guinea pig is in fact toxic to both species of lice, which will live longer without any food than after ingestion of the blood of a guinea pig.

I think that further insight into the specificity of the blood of different substitute hosts may be expected after more biochemical and immunologic research is done. The results of such research may be significant in the control of lice.

Finally, there are certain indications that the blood of humans and animals treated with antibiotics has a noxious effect on lice. This may be explained by the influence of the antibiotics on the symbionts in the mycetome of the lice.

Table 3. Rate of survival of 5 female and 5 male adult *Pediculus humanus humanus* of random age distribution while fed on nonspecific hosts.

Time (days)	Host													
	Mouse		Hamster		Pig		Rat		Guinea pig		Chicken		Pigeon	
	F	M	F	M	F	M	F	M	F	M	F	M	F	M
0	5	5	5	5	5	5	5	5	5	5	5	5	5	5
1	5	5	4	5	5	5	1	3	—	—	2	4	3	4
2	3	4	5	4	4	3	1	2			2	3	3	3
3	2	4	4	3	4	3	—	—			1	2	1	3
4	—	3	4	3	3	2					—	2	1	1
5		3	2	2	3	1						1	—	—
6		1	1	2	—	—						—		
7		1	—	2										
8		—		2										
9				1										
10				1										
11				—										

Note: F—Female, M—Male.

Table 4. Rate of survival of first nymphal stage of *Pediculus humanus humanus* while fed on nonspecific hosts.

Time (days)	Host						
	Mouse	Hamster	Pig	Rat	Guinea pig	Chicken	Pigeon
0	300	120	100	100	100	100	100
1	280	113	88	—	—	59	35
2	189	96	—	Nymph 1		20	11
3	148	57				4	1
4	106	38		Nymph 2		—	—
5	53	12					
6	22	5		Nymph 3			
7	10	3					
8	7	2		Adult			
9	—	2					
10		—					

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Stefan Kryński.[1] *Influence of individual features and environmental temperature on the development of infection and intoxication in lice.* The present work attempts to provide an answer to several questions, namely: (1) do all lice belonging to one defined population react similarly to a harmful agent or are there any individual differences among them; (2) what role in the degree of the louse's sensitivity is played by sex, age, and the duration of starvation; (3) can a louse organism counteract an infection during its development, and (4) what is the influence of environmental temperature on the response of lice to infection or intoxication?

Methods and materials

The lice that we use in our investigations originated from the laboratory colony founded by Weigl in 1918 (*16, 17*). In 1939 they were crossed with lice from the Laboratorio per la Profilassi e lo Studio delle Rickettsiosi (Laboratory for Rickettsiosis Prophylaxis and Research) in Addis Ababa, Ethiopia. They are kept at 32° C and fed once daily on human volunteers. Adult insects 12 days old are used for experiments 20 hours after the last feeding. Following intrarectal injection of the bacterial

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