

Table Summary of available data on effects of temperature on mean egg to adult developmental time¹

Species	15	17.5	20	22.5	25	27.5	30	32.5	35	37.5	Author Year
<i>Blattisocius dentriticus</i> *			15.7	12.5(23)	6.9(26)		5.8(29)	8.8(32)	10.1		Zheng2011
<i>Androlaelaps casalis</i> *					8.7(25.6)	7.3(26.7)	6.3	5(32.8)	7.5(36)		Barker1968
<i>Tyrophagus putrescentrus</i>	31.7(16)		(13.5)19	9.7(22)	9.1	7.6(28)	7		8.5(34)		Qu2015
<i>Tyrophagus putrescentrus</i>	106(10),32.2		15.8		9.4		7.2	8.5	10.5(34)		Sanchez-Romos2001
<i>Habrobracon hebetor</i> *	45.7		18.9		12.3		8.1		7.1		Golizadeh2017
<i>Habrobracon hebetor</i> *	32.7(16)	40.1(16.5)	21.2		13.9(24), 13.3, 11.6(26)	9.9(28)	8.8	8.1(32),7.8			Harris1937
<i>Cheyletus eruditus</i> *	79(10.6)	23(17.1)	17(20.2)			11(26.8)	10(31.5)				Boczek1959
<i>Cheyletus eruditus</i> *		33.8(18.3)		24.2(22)	15.4						Barker1991
<i>Tyrophagus putrescentrus</i>	66.5(11.2)		18	15.6(22.2)	13.8(24.4)	11.5(27.8)	10.8	9.1(32.2)	10.4(33.9)		Barker1967
<i>Anisopteromalus calandrae</i> *		72(18)	27.4		16.9	12.6(28)	11.1		9.9(34)		Chun1992
<i>Habrobracon hebetor</i> *	44.6		19.7		12.3		11.1		8.5		Huang2024
<i>Anisopteromalus calandrae</i> *		63.6(18)	29.8		17.9	13(28)	11.3		10.3(34)		Chun1992
<i>Cephalonomia tarsalis</i> *			26.3(21)		16.7(24)	11.7(27)	11.4				Lukás2005
<i>Tyrophagus putrescentrus</i>	118(10),45.9		24.3				11.6				Kheradmand2007
<i>Plastanoxus westwoodi</i> *	30.7		24.5		15.9		12.4		10.5		Rahman2006
<i>Cephalonomia waterstoni</i> *			47.3		22.4		12.8		8.8	9.9(38)	Flinn1995
<i>Cephalonomia tarsalis</i> *		42.5	29.3		19.8		13.2	10.3	10.6		Eliopoulos2016
<i>Plastanoxus westwoodi</i> *	32.6		26.1		17.5		13.2		11.2		Rahman2006
<i>Cheyletus malaccensis</i> *		41.7	31		19.3		13.3	11.4	12.9		Palyvos2009
<i>Liposcelis decolor</i>			41.8	28.9	24	20.7	14	17.7	13.6	16.3	Tang2008
<i>Anisopteromalus calandrae</i> *	126.3		34.8		18.8	15.7(27)	14		11.3	11.2(37)	Mobarakian2014
<i>Lariophagus distinguendus</i> *		42.1(18)	28		18.8	14.8(28)	14.1	13.8(32)	14.5(34)		Ryoo1991
<i>Anisopteromalus calandrae</i> *	130		40.4		20.5	17.1(27)	14.6		12	13.3(37)	Mobarakian2014
<i>Lariophagus distinguendus</i> *			31		20	16(28)	14.7	14.2(32)	15.5(34)		Ryoo1991
<i>Carpophilus marginellus</i>	63.7(16)		40.5(19)	29.9(22)	21.2	16.4(28)	14.8(31)		14.9(34)		Shao2024
<i>Xylocoris flavipes</i> *			52		24		16		16		Arbogast1975
<i>Xylocoris flavipes</i> *			60(21)		29.4(24)			16.5(32)			Russo2004
<i>Ahasverus advena</i>		69.9	45.7	31.3	26	21.1	16.2	21.8			Jacob1996
<i>Liposcelis decolor</i>			46.2	31.7	26.9	22.8	16.2	20	16.1	20	Tang2008
<i>Theocolax elegans</i> *			53.8		24.5	19.1(28)	16.3	15.6(32)	16.7		Imanura2004
<i>Cheyletus malaccensis</i> *		53	38.6		24.8		17	14.4	15.4		Palyvos2009
<i>Theocolax elegans</i> *			54.4		25.7	19.9(28)	17.1	16.2(32)	18.1		Imanura2004
<i>Piophilha casei</i>	57.4		43.7(19)		23.3	19.7(28)		14.7(32)			Russo2006
<i>Cylas puncticollis</i>			63.7(19)		33.8(24), 24(26)		17.8(31)		18.5(36)		Nteletsana2001
<i>Hypothenemus hampei</i>		63.4(18)	46.8	33.7(23)	26		18				Azrag2020
<i>Phthorimaea operculella</i>		60.1	54.4	33.2	30.9	24.6	18.4				Andreadis2017
<i>Carpophilus hemipterus</i>			46.7	34.2	27.1	20.8	18.7	15	15.4	14.6, 15.4(40)	James2000
<i>Callosobruchus analis</i>					29.9		19.2		29.8	40((37)	Adarsh1969
<i>Liposcelis badia</i>			46.5	33.4	29.7	23.3	19.8	17.2	19.3		Jiang2008
<i>Lyctocoris campestris</i> *		63.8(17)	38.7(21)		27.6		19.9(29)				Parajulee1995
<i>Liposcelis fusciceps</i>				39.9	29.5	23.9	20.1	19.2	18		Gautam2016
<i>Venturia canescens</i> *	104.1	64.4	38.4		25		20.2, 18.6(31)	19(32)			Eliopoulos2003
<i>Plodia interpunctella</i>					28	22.6(28.3)	20.2(31.7)		25.1		Johnson1992
<i>Liposcelis rufa</i>				43.4	32.6	26.5	20.6	17.8	17.9	17.5, 19.9(40)	Gautam2010
<i>Oryzaephilus surinamensis</i>			69.1	30.3			20.7		18		Thomas1940
<i>Carpophilus humeralis</i>			65.4	42.1	32.5	25.8	20.8	10.4	16.7	16.5	James2000
<i>Sitotroga cerealella</i>				25	22.6 (24)		20.9(28)	17.4(32)			Akter2013
<i>Cryptolestes pusillus</i>			57.1	44.8	28.9	22.5	21	17.8	17.1	20.3	Currie1967
<i>Liposcelis bostrychophila</i>			41.9	36.4	34.8	24.4	21	18.1	21.5		Wang2000
<i>Callosobruchus chinensis</i>			57.1		29	26	21.3	24.4			Utida1971

Species	15	17.5	20	22.5	25	27.5	30	32.5	35	37.5	Author Yr
Acantoscelides obtectus		80.6	42.3(21)		31.7(24.7)		21.4(31.1)				Menusan1936
Cryptolestes ferrugineus				53.6	40.5	26.9	21.4	20	18.7	19.7,20.1(40), 20.8(42)	Smith1965
Lycotocoris campestris*		63.4(17)	40.5(21)		28.4		21.5				Parajulee1995
Callosobruchus rhodesianus		85		36.7	30.9		21.6				Howe1964
Callosobruchus maculatus			60.4(19.8)	36.9(22.6)	28.4(25.6)	23.1(28.8)		20.6(31.7)			Kutcherov2020
Liposcelis pearmani				38.8	28.2	25.3	21.9	18.7	21.6		Aminatou2011
Acantoscelides obtectus		79.9	48.8(21)		32.3(24.7)		22(31.1)				Menusan1936
Callosobruchus chinensis					31.4		22		24.4		Giga1983
Creophilus maxillosus*	122.2	76.9	43.1	37.6	29.9	27.6	22.2				Fratczak- Lagiewska2020
Cryptolestes ugandae		135	56.4	38.6	34.7	27.6	22.3	21.6	29.6		Lefkovitch1957
Callosobruchus maculatus		139.1(18)	57.4(21)		39.9		22.3(31)		18.4		El-Sawaf1956
Liposcelis paeta				45.4	32.2	26.4	22.5	15.6	14.2	11.5	Wang2009
Cryptolestes pusilloides	119	71.7	54.2	35.9	27.2	26.7	22.6	21.4	22	22	Lefkovitch1964
Callosobruchus chinensis	122.3(16)	55.9(18)		37(22)	29.6(26)		22.9		20.4(34)	19.2(38)	Maharjan2017
Venturia canescens*		53.7	43.9	34.2	27.4	20.8	23	21.8			Spanoudis2012
Callosobruchus maculatus			51		31		23		19	25(38)	Mookerjee1964
Liposcelis obscura				58.8	41.3	27.7	23.3	19.7	17.7	14.7, 14.3(40), 15.3(42.5)	Ocran2021
Carpophilus dimidatus			69.9	46.2	32.1		23.6				Porter1986
Carpophilus dimidatus		94	55.5		35.8	30.8		26			Lefkovitch1966
Oryzaephilus surinamensis		106(18)			49.7(24)	32.6(28)	24	22.5(32)	24.9(36)	29.3(38)	Lergenmüller1958
Oryzaephilus surinamensis			85		34.1		24.1	22.2	36.1		Nika2021
Oryzaephilus surinamensis			70.6		32.7		24.1		23.7		Thomas1940
Liposcelis pearmani				49.2	34.9	26.8	24.2	21.9	23.8		Aminatou2011
Liposcelis rufa				47.4	37.3	29.5	24.5	21.7	24.6	21.6,22(40)	Gautam2010
Liposcelis entomophila			71.9	57.6	44.5	35	24.5	23.1	21.7		Wang1998
Liposcelis fusciceps				44	34.2	27.9	24.6	21.1	19.7		Gautam2016
Callosobruchus analis			74.6		35.6	35.2	24.7	28.3			Utida1971
Carpophilus mutilatus			55.8	42.1	34.2	27.1	25	18.7			James2000
Dufouriella ater*			41.5		38		25.2		19.5		Arbogast1984
Omosita colon	95.3(16)			45.9(22)	34.9	30(28)	25.2(31)				Wang2020
Callosobruchus maculatus			90.6		28		25.3		23.2		Giga1983
Callosobruchus chinensis	127.9(16)	58.1(18)		37.1(22)	33.6(26)		25.4		19.9(34)	19.3(38)	Maharjan2017
Liposcelis yunnanensis			64.3	45.8	37.8	23.9	25.6	22.6	16.1	16.2	Hassan2013
Liposcelis brunnea				43.7	34.4	30.6	25.7	24.6	25.2		Opit2009
Typhaea stercorea			74.2	37.4	38.8	29.4	25.8				Jacob 1988
Oryzaephilus acuminatus			69.5	50.4	36.8	31.3	26	19.5	21.3		Jacob1981
Sitophilus granarius	144		56.5	49	36.5	29	26				Eastham 1947
Tribolium castaneum			147.6	73.7	48.2	36.5	26.3	22.1	20.1	20.2, 30.7(40)	Howe1956
Sitophilus zeamais	193.6	93.3	63.7		32.9		26.3	30(32)			Throne1994
Sitophilus oryzae			49		30.9	25.9(28)	26.8	30.1(33)			Ryoo1988
Sitophilus oryzae					33, 31(26)		27	29(32)			Reddy1950
Zabrotes subfasciatus			86.4		37.7	34.2	27.1	34.2(32)			Utida1971
Prostephanus truncatus		167.4(18)	83.8	53.4	39.3	35.7	27.2	25.4	30.7	39.2(37)	Bell1982
Dermestes maculatus	114(15)		73.7	55(22)	43.4(24)	38.3(27)	27.3				Zanetti2016a
Callosobruchus subinnotatus					43.8		27.6		26.6		Lale2003
Callosobruchus rhodesianus			73.4		35.9	34.8	27.6				Utida1971
Callosobruchus rhodesianus			74.4		35.9		28		29.5		Giga1983
Plodia interpunctella			59		37.3		28.2		37.9		Arbogast2007

Species	15	17.5	20	22.5	25	27.5	30	32.5	35	37.5	Author Yr
Callosobruchus chinensis						27.5(27)	28.3	31.6(33)	36.8(36)		Singh1964
Plodia interpunctella					38.6	31.4(28.3)	28.4(31.7)		31.4		Johnson1992
Cylas formicarius elegantulus			76.8		34.4	26.6(27)	28.8				Mullen1981
Cryptolestes pusillus	137.4		79.4(21)		44.4		29				Davies1949
Tribolium confusum			117.9	68.5	46.9	36	29	25	26.8	34	Howe1960
Plodia interpunctella					38.2	31.3(28.3)	29(31.7)		42.4		Johnson1992
Plodia interpunctella			66.2		36.8		29.1		38.3		Arbogast2007
Cadra cautella	145	105.4	61.5	54.8	41.5	38.1	29.4	30.8	34.4		Burges1965
Latheticus oryzae						42.6	29.6		20.3	19.1(37)	Nowosielski-Slepowron1980
Tribolium audax		334	104.5	84.1	50.5	34.1	31.1	25.9	27.4		Smith1991
Sitotroga cerealella					39.7(26)		31.2	33.2(32)	35.5		Demissie2014
Palorus ratzeburgii			85.1	64.5	50.8	36.3	31.3	26.1	26.1	37.5	Halstead1967
Dermestes frischii			97.4(19)	69.6(22)	46.9	39.1(28)	31.3(31)		33.5(34)		Hu2023
Tribolium madens			243.3	104.9	51.3	41.4	31.4	28.2	25.3		Howe1962
Liposcelis brunnea				49.6	39.1	36.8	32.7	30.5	27.7		Opit2009
Tribolium madens			115.2	75.8	54.3	34.1	32.7	27.3	24		Smith1991
Cryptolestes capensis	157.3(15.5)	103.1	72	61.6	43	38.5	32.7	31			Lefkovitch1962
Callosobruchus phaseoli			68.5		44.1	44.4	33.9				Utida1971
Callosobruchus analis					40.5		33.9		39.5		Giga1983
Cryptolestes turcicus		143.4	72.1	55	37.8	37.8	34.5	51.7	30.4		Lefkovitch1962
Ephestia elutella	167		70		45		35				Bell1975
Dermestes maculatus		96.5(18)	81	58.2(23)	44	39.2(28)	35.1	32.3(33)	34.1		Raspi1995
Latheticus oryzae					114.5		35.2		21.9	23.5(37)	Hafez1966a
Sitotroga cerealella	151.5		71.7		50.4		35.8		51.1		Perez Mendoza2004
Ephestia figulilella		122	85	77	55	51	36	56	46		Cox1974
Oryzaephilus surinamensis			80.7		40.8		36				Thomas1940
Alphitobius diaperinus			164.2		59.9		36.1		28.7	30.65(38)	Rueda1996
Tribolium freemani			266.1	267	73.9	49.5	36.4	32.2	34.2		Imura1984
Dermestes frischii			112.4	74.3	53.7	47.7		30.5	33.3	45.9	Howe1953
Trogoderma granarium							37.6	29.7	29.7	35.1(40)	Vir 1980
Necrobia rufipes					66.6	46.1			29.5		Bhuiyan2000
Dermestes maculatus			89.7		59.2		38.3		36.4		Richardson2001
Necrobia rufipes				113.2(22)	66.2	50.6(28)	38.3(31)		38(34), 31.2(36)		Hu2020
Plodia interpunctella		170.5(17)	65.7		38.8	36.2		33.4(32)			Na2000
Plodia interpunctella		179.7(17)	83.8		48	43.7(28)		40(32)			Na2000
Plodia interpunctella		13(17)	15.9		21.2	22.6(28)		49.2(32)			Na1998
Trogoderma granarium							39	27.6	30	41.3(40)	Vir 1980
Palorus subdepressus			123.5	72.5	50.8	44.6	39.1	36.5	35.1		Halstead1967
Corcyra cephalonica		59(18)	74(21)		48(24),43.8 (26)	41(28)	39.2		34(34),69(36)		Rossini2021
Stegobium paniceum		190.1	95.7	69.2	54.4	42.1	39.4	47.1			Lefkovitch1967
Gnathocerus maxillosus			129.5	80.8	61	45	39.6	41.6	34.4		Ntifo1973
Dermestes haemorrhoidalis			101.1		54.2		40.8	56			Coombs1979
Oryzaephilus mercator			72				41.1			28.1(37)	Lale1996
Tribolium destructor	212(15-17)		99(19-20)		64(25-26)	59(27), 46(28)	42(30-31)				
							39(30.5-31.5)				
Trogoderma granarium			66.2		52.9		42.6		37.4	36(40)	Mathlein1943
Trogoderma variabile						49.6(26.7)		33.6(32.2)		34.6(37.8)	Akbar1969
Stegobium paniceum		140.1	93.3	68.1	55	42.8	43.1	51			Partida1975
Trogoderma granarium							43.8	27.4	30.1	35.2(40)	Lefkovitch1967
Dermestes tessellatocollis	163.9(16)		103.6(19)	63.6(22)	51.5	47.9(28)	44.6(31)		41.8(34)		Vir 1980
Rhyzopertha dominica		135.4(18)	114.8		56.4(24)	36.9(28)		32.3(32)	33.1		Wang2021
											Faroni1992

Species	15	17.5	20	22.5	25	27.5	30	32.5	35	37.5	Author Yr
Rhyzopertha dominica						51.5(27)	44.6	30.7(33)	34.1(36)		Bains1971
Coelopalorus foveicollis			162.1	96.5	67.3	52.7	45.1	40.6			Halstead1967
Lasioderma serricorne			98.3(21)		75(24)	69.8(27)	45.9	43.8(33)			Wang2021
Trogoderma variabile						56.5(26.7)		35.2(32.2)		39(37.8)	Partida1975
Idaea inquinata			123.5(21)		49.3(26)		46.5(29)		78.7(34)		Limonata2010, 2013
Dasytes rugosella					73.4	63.8(28)	47.1	36.8(33)			Iheagwam1989
Necrobia ruficollis				93(22)	70.7	65.3(28)	47.3(31)		56.7(34)		Wang2022
Cadra cautella	237.9(16)	187.6(18)	158.9	118.7(22)	73.5(24), 71.4(26)	52.6(28)	48.8	42.2(32)	42.9(34)		Nawrot1979
Dermestes maculatus							48.8		35.9	32.9(40)	Thornton1981
Lophocateres pusillus			180.2		71.2		49.1		48.8		Halstead1968
Ephestia kuehniella	163.8(15)	140.3	98.4	75.9	61	63	50.2				Pakyari2018
Ephestia kuehniella	193.5	126.8(18)		95.9(22)	79.8	85(28)					Jacob1977
Ephestia kuehniella			69	61(21.5), 56.2, 51.6(23.5)	46.2	42.8(26.5),40.6					Siddiqui1973
Trogoderma inclusum						55.1(26.7)		30.4(32.2)		36.1(37.8)	Strong1975
Trogoderma granarium			229.8	183.1(22)	151.8(24),122.8(26)	60.7(28)	51.3	43.9(32)	37.6(34), 34.3(36)	36.8(38), 49.2(40)	Staneva2002
Dinoderus minutus	132	106.3(18)			63.7	57	53.8				Garcia2009
Murmidius ovalis			229.4		73.4		57.1		54.6		Halstead1968
Trogoderma inclusum						60.5(26.7)		34.3(32.2)		40(37.8)	Strong1975
Amyelois transitella					71.6	55.3	58.5				Wade1961
Alphitobius diaperinus	121.6(15.6)		89.8(20.1)			69.4(26.7)		50.6(32.2)		48(37.8)	Wilson1969
Mezium affine			134.9		78		61.8	61.6(33)			Howe1953
Ptinus tectus	116.8		62.4		52.7		66.3(28)				Ewer1942
Dermestes peruvianus	316.6				64.6		79.3				Coombs1979
Necrobia rufipes				141.7(22)	126.5	93.2(28)	83.731)				Hasan2022
Tinea pellionella			68.5 (21.5)		48.3		89.8				Cheema1956
Amphibolus venator*					188.4	131.4	95.8	73.9	70.7		Nishi2002

1. Species names for natural enemies are followed by *. Because authors use different temperatures the number of columns is reduced by noting in parentheses when temperatures were other than 15, 17.5, 20, 22.5, 25, 27.5, 30, 32.5, and 37.5. Egg to adult developmental time at 30°C was estimated for 10 species (16 studies) by interpolation between that at a higher and that at a lower temperature or from other studies with taxonomically similar species so that data could be sorted by the development time at 30°C. Data as close as possible to 70% relative humidity was included whenever possible and only data collected at >50% relative humidity was included.