Summary

The present investigation **"Studies on Synthetic, Biological and Agricultural Importance of some new Fluorine based Organic Derivatives of Tin"** is undertaken to explore the biological and agricultural importance of some organotin compounds. The observation made by earlier workers particularly on antimicrobial, antitumor and other biocidal activity of organotin carboxylates, amides and other groups, it was found that organic moieties attached with metals are known to act as pro-active drugs which make their study really fascinating.

The present work deals with the synthesis of some newer compounds in view to examine their biomedicinal efficacy. The nonplatinum group metals especially those belonging to nontransition p-block elements, tin attracting considerable attention. The aforesaid investigation is described in following chapters as given below:-

CHAPTER-1

This chapter deals with general introduction covering the definition, possible types of organometallic derivatives, commercial-industrial development published in the form of books and monographs.

CHAPTER-2

The second chapter deals a brief outline of physico-chemical properties of group14 elements which are related with the study of organometallic compounds.

CHAPTER-3

This chapter describes the current literature review covering the last twenty years relevant to present study and discussed in details in two sections, A and B: In section-A, the recent literature reported for the synthetic aspects of organotin compounds are discussed. The section- B of this chapter deals the biomedicinal aspects of organotin compounds covering current literature.

CHAPTER-4

This Chapter of the present work compiled in two sections; section-A deals the synthesis of various novel triorganotin (IV) amides along with their characterization using different experimental techniques. The preparation of triorganotin (IV) amides was carried out by the reaction of R_3SnCl and suitable amide in presence of triethylamine, as HCl acceptor, under room temperature and nitrogen atmosphere.

$$R_3SnCl + HL \xrightarrow{Et_3N} R_3SnL + Et_3N.HCl$$

$R = (C_6H_5), (C_6F_5), (C_6H_4F)$, HL = Succinimide, Phthalimide

All the newly synthesized compounds were crystalline solids, air stable and soluble in common organic solvents. The compounds were further characterized by using analytical techniques such as elemental analysis, infrared spectroscopy to ascertain their structures and explore their biological properties.

Table-1 Physicochemical properties of triorganotin (IV) amides

S.N	Compounds	Formula	Formula Weight	M.P. (°C)	Yield (%)	Solvent
1	$(C_6H_5)_3Sn$(succinimide)	$C_{22}H_{19}NO_2Sn$	447.71	88	80	Pet.-ether (40-60 ºC)
2	$(C_6H_5)_3Sn$(phthalimide)	$C_{26}H_{19}NO_2Sn$	494.71	80	85	Pet.-ether (40-60 ºC)
3	$(C_6F_5)_3Sn$(succinimide)	$C_{22}H_4NO_2F_{15}Sn$	716.71	95	70	Pet.-ether (60-80 ºC)
4	$(C_6F_5)_3Sn$(phthalimide)	$C_{26}H_4NO_2F_{15}Sn$	764.71	90	75	Pet.-ether (40-60 ºC)
5	$(C_6H_4F)_3Sn$(succinimide)	$C_{22}H_{16}NO_2F_3Sn$	500.71	90	65	Pet.-ether (60-80 ºC)
6	$(C_6H_4F)_3Sn$(phthalimide)	$C_{26}H_{16}NO_2F_3Sn$	548.71	85	70	Pet.-ether (40-60 ºC)

Table -2 Analytical data of triorganotin compounds

S.N.	Molecular Formula	Elemental Analysis			IR (cm^{-1})	
		C (%)	H (%)	N (%)	V_{asym}(CO)	V_{sym}(CO)
1	$C_{22}H_{19}NO_2Sn$	59.09	4.25	3.13	1706 vs	1308ms
2	$C_{26}H_{19}NO_2Sn$	63.06	3.84	2.82	1758vs	1354ms
3	$C_{22}H_4NO_2F_{15}Sn$	52.72	0.55	2.79	1726ms	1326ms
4	$C_{26}H_4NO_2F_{15}Sn$	56.86	0.52	2.55	1729vs	1329ms
5	$C_{22}H_{16}NO_2F_3Sn$	36.83		1.95	1732vs	1332ms
6	$C_{26}H_{16}NO_2F_3Sn$	40.79		1.83	1740ms	1338ms

Section-B of this chapter describes the various biomedicinal studies including antitumor, antimicrobial along with toxicological studies on insects, which damage the Indian agricultural crops, using standard methods and the results are surprising that these compounds show higher to moderate activity.

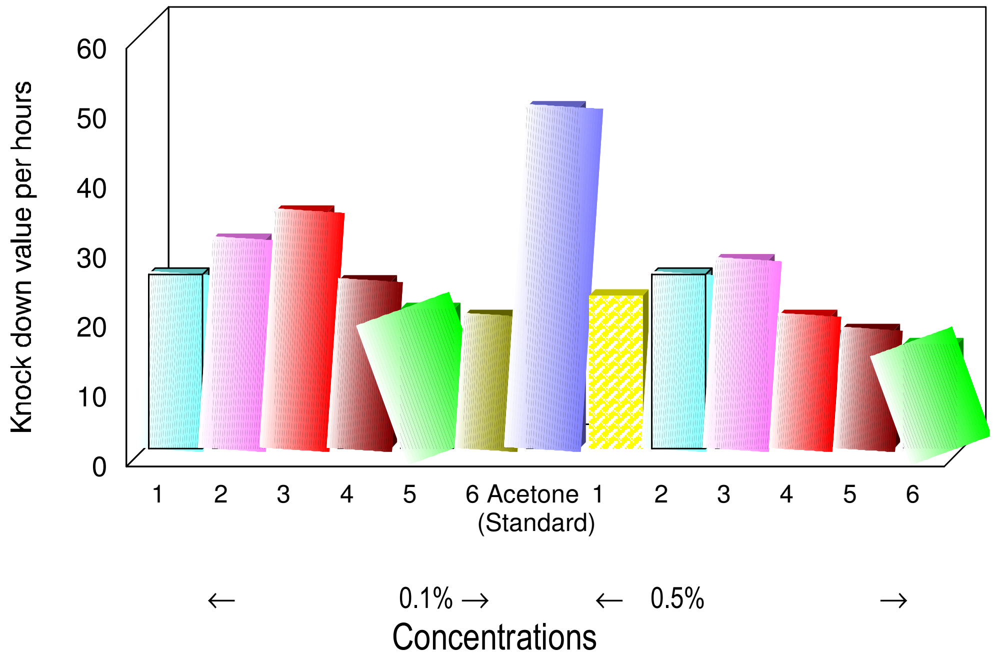

Fig.1 Insecticidal activity of triorganotin (IV) amides

Table-3 Antitumor activity of diorganotin (IV) diamides

S. N.	Compounds	MCF-7 Cell No. x 10^4	EVSA-7 Cell No. x 10^4	Activity
1	$(C_6H_5)_3Sn$(succinimide)	8.79 ± 0.52	8.42 ± 0.46	Positive
2	$(C_6H_5)_3Sn$(phthalimide)	11.59±1.06	11.29±1.02	Negative
3	$(C_6F_5)_3Sn$(succinimide)	9.19±0.92	9.29±0.88	Positive
4	$(C_6F_5)_3Sn$(phthalimide)	8.95±0.67	8.55±0.62	Positive
5	$(C_6H_4F)_3Sn$(succinimide)	9.17 ± 0.90	8.6 7 ± 0.69	Positive
6	$(C_6H_4F)_3Sn$(phthalimide)	8.79 ± 0.52	8.42 ± 0.46	Positive
7	Negative control	10.21±1.01	10.22±1.01	–
8	Positive control	40.26±3.23	41.23±3.28	–

Table-4: Antibacterial activity (Zone of Inhibition (mm) dia. ± S.E)

S. No.	Compounds	*Pseudomonas aeruginosa*	*Staphylococcus aureus*	*Klebsiela pneumoniae*
1.	$(C_6H_5)_3Sn$(succinimide)	18.66±0.66	07.83±0.44	10.5±0.76
2.	$(C_6H_5)_3Sn$(phthalimide)	17.33±0.6	19.00±0.57	15.00±0.57
3.	$(C_6F_5)_3Sn$(succinimide)	15.66±0.33	16.00±0.57	17.00±0.57
4.	$(C_6F_5)_3Sn$(phthalimide)	08.0±0.28	19.00±0.57	13.00±0.50
5.	$(C_6H_4F)_3Sn$(succinimide)	11.33±0.66	11.00±0.57	08.5±0.29
6.	$(C_6H_4F)_3Sn$(phthalimide)	11.00±0.57	08.10±0.16	12.00±1.15
7.	Ampicilin (standard)	18.72±0.68	18.11±0.32	18.08±0.28

Table-5: Antifungal activity

S. No.	Compounds	*Con.* μg/ml	*Aspergillus flavus* (dia.mm)	% Inhibition	*Aspergillus niger* (dia.mm)	% Inhibition
1	$(C_6H_5)_3Sn$(succinimide)	50	0.5	83.3	0.8	60.0
		100	0.01	96.7	0.5	75.0
2.	$(C_6H_5)_3Sn$(phthalimide)	50	0.4	86.7	0.5	75.0
		100	0.2	93.3	0.2	90.0
3.	$(C_6F_5)_3Sn$(succinimide)	50	0.6	80.0	0.5	75.0
		100	0.4	86.7	0.2	90.0
4.	$(C_6F_5)_3Sn$(phthalimide)	50	0.8	73.3	0.8	60.0
		100	0.5	83.3	0.4	80.0
5.	$(C_6H_4F)_3Sn$(succinimide)	50	0.7	76.6	0.6	70.0
		100	0.4	86.7	0.1	95.0
6.	$(C_6H_4F)_3Sn$(phthalimide)	50	1.0	66.6	0.5	75.0
		100	0.8	73.3	0.2	90.0
7.	Control		3.0	-	2.0	-

Table-6: Contact Toxicity

S. No.	Compounds	Fiducial limits	Slop ± S.E.	Chi. Square	LC_{50}/LD_{50}
1.	$(C_6H_5)_3Sn$(succinimide)	1.87-12.07	1.09±0.19	1.62 (3)	3.53
2.	$(C_6H_5)_3Sn$(phthalimide)	1.57-9.32	1.07±0.17	0.72 (3)	2.83
3.	$(C_6F_5)_3Sn$(succinimide)	0.28-0.40	1.96±0.16	4.39 (3)	0.33
4.	$(C_6F_5)_3Sn$(phthalimide)	0.39-0.59	1.67±0.15	5.62 (3)	0.46
5.	$(C_6H_4F)_3Sn$(succinimide)	0.43-0.75	1.63±0.6	2.94 (3)	0.58
6.	$(C_6H_4F)_3Sn$(phthalimide)	1.87-12.07	1.09±0.19	1.63 (3)	3.52

Table-7: Stomach Toxicity

S. No.	Compounds	Fiducial limits	Slop ± S.E.	Chi. Square	LC_{50}/LD_{50} at 24 hrs.
1.	$(C_6H_5)_3Sn$(succinimide)	1.61-9.55	1.45±0.17	0.68 (3)	2.97
2.	$(C_6H_5)_3Sn$(phthalimide)	0.86-1.99	1.28±0.16	0.80 (3)	1.20
3.	$(C_6F_5)_3Sn$(succinimide)	0.49-0.76	1.57±0.16	2.78 (3)	0.60
4.	$(C_6F_5)_3Sn$(phthalimide)	0.55-0.90	1.48±0.16	3.37 (3)	0.67
5.	$(C_6H_4F)_3Sn$(succinimide)	0.56-0.97	1.33±0.15	0.63 (3)	0.75
6.	$(C_6H_4F)_3Sn$(phthalimide)	0.85-1.82	1.22±0.16	0.72 (3)	1.12

Table-8: Antifeedant Activity

S. No.	Compounds	Fiducial limits	Slop ± S.E.	Chi. Square	LC_{50}/LD_{50} at 24 hrs.
1.	$(C_6H_5)_3Sn$(succinimide)	0.82-3.41	1.81±0.14	0.43 (3)	1.35
2.	$(C_6H_5)_3Sn$(phthalimide)	0.68-1.72	1.03±0.14	0.66 (3)	0.98
3.	$(C_6F_5)_3Sn$(succinimide)	0.43-0.87	1.03±0.14	0.34 (3)	0.58
4.	$(C_6F_5)_3Sn$(phthalimide)	0.62-1.42	1.06±0.14	1.07 (3)	0.86
5.	$(C_6H_4F)_3Sn$(succinimide)	0.83-2.33	1.08±0.15	0.79 (3)	1.24
6.	$(C_6H_4F)_3Sn$(phthalimide)	0.72-2.41	0.93±0.14	0.22 (3)	1.13

Table-9: Acaricidal Activity

S. No.	Compounds	Fiducial limits	Slop ± S.E.	Chi. Square	LC_{50}/LD_{50} at 24 hrs.
1.	$(C_6H_5)_3Sn$(succinimide)	0.12-0.30	0.78±0.08	1.70 (3)	0.18
2.	$(C_6H_5)_3Sn$(phthalimide)	0.14-0.31	0.96±0.09	7.52 (3)	0.20
3.	$(C_6F_5)_3Sn$(succinimide)	0.05-0.10	0.93±0.08	13.22 (3)	0.06
4.	$(C_6F_5)_3Sn$(phthalimide)	0.04-0.09	0.69±0.06	4.64 (3)	0.05
5.	$(C_6H_4F)_3Sn$(succinimide)	0.05-0.09	0.16±0.09	12.67 (3)	0.07
6.	$(C_6H_4F)_3Sn$(phthalimide)	0.07-0.22	0.76±0.06	5.63 (3)	0.14

CHAPTER-5

This Chapter has two sections, section-A which deals the synthesis of diorganotin (IV) diamides and their characterization using different experimental techniques. The preparation of diorganotin (IV) diamides was carried out by the reaction of R_2SnCl_2 and suitable amide in presence of triethylamine, as HCl acceptor, under room temperature and nitrogen atmosphere.

$$R_2SnCl_2 + 2HL \xrightarrow{Et_3N} R_2SnL_2 + 2Et_3N.HCl$$

R = (C_6H_5), (C_6F_5), (C_6H_4F), HL = Succinimide, Phthalimide

All the newly synthesized compounds were crystalline solids, air stable and soluble in common organic solvents. The compounds were further characterized by using analytical techniques such as elemental analysis, infrared spectroscopy to ascertain their structures.

Table-1 Physicochemical properties of diorganotin (IV) diamides

S.N.	Compounds	Formula	Formula Weight	M.P. (°C)	Yield (%)	Solvent
1	$(C_6H_5)_2Sn(succinimide)_2$	$C_{20}H_{18}O_4N_2Sn$	469	82	65	Pet-ether (40-60 ºC)
2	$(C_6H_5)_2Sn(phthalimide)_2$	$C_{28}H_{18}O_4N_2Sn$	565	76	85	Pet-ether (40-60 ºC)
3	$(C_6F_5)_2Sn(succinimide)_2$	$C_{20}F_{10}H_8O_4N_2Sn$	649	82	70	Pet-ether (60-80 ºC)
4	$(C_6F_5)_2Sn(phthalimide)_2$	$C_{28}F_{10}H_8O_4N_2Sn$	745	80	65	Pet-ether (40-60 ºC)
5	$(C_6H_4F)_2Sn(succinimide)_2$	$C_{20}F_2H_{16}O_4N_2Sn$	505	90	60	Pet-ether (60-80 ºC)
6	$(C_6H_4F)_2Sn(phthalimide)_2$	$C_{28}F_2H_{16}O_4N_2Sn$	601	86	70	Pet-ether (40-60 ºC)

Section-B of this chapter describes various biomedicinal studies along with toxicological studies on insects using standard methods.

Table-2 Antitumor activity of diorganotin (IV) diamides

S. No.	Compounds	MCF-7 Cell No. x 10^4	EVSA-7 Cell No. x 10^4	Activity
1	$(C_6H_5)_2Sn(succinimide)_2$	12.31±1.02	12.39±1.03	Negative
2	$(C_6H_5)_2Sn(phthalimide)_2$	9.17 ± 0.90	8.6 7 ± 0.69	Positive
3	$(C_6F_5)_2Sn(succinimide)_2$	8.79 ± 0.52	8.42 ± 0.46	Positive
4	$(C_6F_5)_2Sn(phthalimide)_2$	8.95±0.67	8.55±0.62	Positive
5	$(C_6H_4F)_2Sn(succinimide)_2$	11.59±1.06	11.29±1.02	Negative
6	$(C_6H_4F)_2Sn(phthalimide)_2$	9.19±0.92	9.29±0.88	Positive
7	Negative control	10.21±1.01	10.22±1.01	–
8	Positive control	40.26±3.23	41.23±3.28	–

Table-3: Antibacterial activity (Zone of Inhibition (mm) dia. ± S.E)

S. No.	Compounds	*Pseudomonas aeruginosa*	*Staphylococcus aureus*	*Klebsiela pneumoniae*
1.	$(C_6H_5)_2Sn(succinimide)_2$	11.00±0.57	08.10±0.16	12.00±1.15
2.	$(C_6H_5)_2Sn(phthalimide)_2$	11.33±0.66	11.00±0.57	08.5±0.29
3.	$(C_6F_5)_2Sn(succinimide)_2$	08.0±0.28	19.00±0.57	13.00±0.50
4.	$(C_6F_5)_2Sn(phthalimide)_2$	17.33±0.6	19.00±0.57	15.00±0.57
5.	$(C_6H_4F)_2Sn(succinimide)_2$	18.66±0.66	07.83±0.44	10.5±0.76
6.	$(C_6H_4F)_2Sn(phthalimide)_2$	15.66±0.33	16.00±0.57	17.00±0.57
7.	Ampicilin (standard)	18.72±0.68	18.11±0.32	18.08±0.28

Table-4: Antifungal activity

S. No.	Compounds	*Con.* µg/ml	*Aspergillus flavus* (dia.mm)	% Inhibition	*Aspergillus niger* (dia.mm)	% Inhibition
1	$(C_6H_5)_2Sn(succinimide)_2$	50	0.6	80.0	0.5	75.0
		100	0.4	86.7	0.2	90.0
2.	$(C_6H_5)_2Sn(phthalimide)_2$	50	0.7	76.6	0.6	70.0
		100	0.4	86.7	0.1	95.0
3.	$(C_6F_5)_2Sn(succinimide)_2$	50	1.0	66.6	0.5	75.0
		100	0.8	73.3	0.2	90.0
4.	$(C_6F_5)_2Sn(phthalimide)_2$	50	0.8	73.3	0.8	60.0
		100	0.5	83.3	0.4	80.0
5.	$(C_6H_4F)_2Sn(succinimide)_2$	50	0.5	83.3	0.8	60.0
		100	0.1	96.7	0.5	75.0
6.	$(C_6H_4F)_2Sn(phthalimide)_2$	50	0.4	86.7	0.5	75.0
		100	0.2	93.3	0.2	90.0
7.	Control		3.0	-	2.0	-

Table-5: Contact Toxicity

S. No.	Compounds	Fiducial limits	Slop ± S.E.	Chi. Square	LC_{50}/LD_{50}
1.	$(C_6H_5)_2Sn(succinimide)_2$	1.87-12.07	1.09±0.19	1.62 (3)	3.53
2.	$(C_6H_5)_2Sn(phthalimide)_2$	1.57-9.32	1.07±0.17	0.72 (3)	2.83
3.	$(C_6F_5)_2Sn(succinimide)_2$	0.28-0.40	1.96±0.16	4.39 (3)	0.33
4.	$(C_6F_5)_2Sn(phthalimide)_2$	0.39-0.59	1.67±0.15	5.62 (3)	0.46
5.	$(C_6H_4F)_2Sn(succinimide)_2$	0.43-0.75	1.63±0.6	2.94 (3)	0.58
6.	$(C_6H_4F)_2Sn(phthalimide)_2$	1.87-12.07	1.09±0.19	1.63 (3)	3.52

Table-6: Stomach Toxicity

S. No.	Compounds	Fiducial limits	Slop ± S.E.	Chi. Square	LC_{50}/LD_{50} at 24 hrs.
1.	$(C_6H_5)_2Sn(succinimide)_2$	1.61-9.55	1.45±0.17	0.68 (3)	2.97
2.	$(C_6H_5)_2Sn(phthalimide)_2$	0.86-1.99	1.28±0.16	0.80 (3)	1.20
3.	$(C_6F_5)_2Sn(succinimide)_2$	0.49-0.76	1.57±0.16	2.78 (3)	0.60
4.	$(C_6F_5)_2Sn(phthalimide)_2$	0.55-0.90	1.48±0.16	3.37 (3)	0.67
5.	$(C_6H_4F)_2Sn(succinimide)_2$	0.56-0.97	1.33±0.15	0.63 (3)	0.75
6.	$(C_6H_4F)_2Sn(phthalimide)_2$	0.85-1.82	1.22±0.16	0.72 (3)	1.12

Table-7: Antifeedant Activity

S. No.	Compounds	Fiducial limits	Slop ± S.E.	Chi. Square	LC_{50}/LD_{50} at 24 hrs.
1.	$(C_6H_5)_2Sn(succinimide)_2$	0.82-3.41	1.81±0.14	0.43 (3)	1.35
2.	$(C_6H_5)_2Sn(phthalimide)_2$	0.68-1.72	1.03±0.14	0.66 (3)	0.98
3.	$(C_6F_5)_2Sn(succinimide)_2$	0.43-0.87	1.03±0.14	0.34 (3)	0.58
4.	$(C_6F_5)_2Sn(phthalimide)_2$	0.62-1.42	1.06±0.14	1.07 (3)	0.86
5.	$(C_6H_4F)_2Sn(succinimide)_2$	0.83-2.33	1.08±0.15	0.79 (3)	1.24
6.	$(C_6H_4F)_2Sn(phthalimide)_2$	0.72-2.41	0.93±0.14	0.22 (3)	1.13

Table-8: Acaricidal Activity

S. No.	Compounds	Fiducial limits	Slop ± S.E.	Chi. Square	LC_{50}/LD_{50} at 24 hrs.
1.	$(C_6H_5)_2Sn(succinimide)_2$	0.12-0.30	0.78±0.08	1.70 (3)	0.18
2.	$(C_6H_5)_2Sn(phthalimide)_2$	0.14-0.31	0.96±0.09	7.52 (3)	0.20
3.	$(C_6F_5)_2Sn(succinimide)_2$	0.05-0.10	0.93±0.08	13.22 (3)	0.06
4.	$(C_6F_5)_2Sn(phthalimide)_2$	0.04-0.09	0.69±0.06	4.64 (3)	0.05
5.	$(C_6H_4F)_2Sn(succinimide)_2$	0.05-0.09	0.16±0.09	12.67 (3)	0.07
6.	$(C_6H_4F)_2Sn(phthalimide)_2$	0.07-0.22	0.76±0.06	5.63 (3)	0.14

CHAPTER-6

The Chapter **6** has two sections, section-A which deals the synthesis of triorganotin (IV) carboxylates and their characterization using different experimental techniques. The compounds were synthesized by using the suitable triorganotin (IV) halide and respective carboxylic acid in presence of triethylamine at room temperature for about 4-5 hours. The $Et_3N.HCl$ formed would be filtered off and the filtrate on concentration in vacuum gave crystalline solid, which was recrystallised from petroleum ether (40-60°C).

$$R_3SnCl + HL \xrightarrow{Et_3N} R_3SnL + Et_3N.HCl$$

HL = Carboxylic acids

All the newly synthesized compounds were crystalline solids, air stable and soluble in common organic solvents. The compounds were further characterized by using analytical techniques such as elemental analysis, infrared spectroscopy.

Table-1 Physicochemical Properties of triorganotin(IV)carboxylate

S.N.	Compounds	Formula	M.P (°C)	Yield (%)	Color	Solvent
1	$(C_6H_5)_3Sn(OOC.CH_3)$	$C_{20}H_{18}O_2Sn$	128-130	62	white	Pet.Ether
2	$(C_6H_5)_3Sn(OOC.CH_2Cl)$	$C_{20}H_{17}O_2SnCl$	122-125	65	Off-white	Pet.Ether
3	$(C_6H_5)_3Sn(OOC.CHCl_2)$	$C_{20}H_{16}O_2SnCl_2$	119/120	70	Off-white	Pet.Ether
4	$(C_6H_5)_3Sn(OOC.CCl_3)$	$C_{20}H_{15}O_2SnCl_3$	115-117	75	Off-white	Pet.Ether
5	$(C_6H_5)_3Sn(OOC.CF_3)$	$C_{20}H_{15}O_2SnF_3$	118-120	82	white	Pet.Ether
6	$(C_6F_5)_3Sn(OOC.CH_3)$	$C_{20}F_{15}H_3O_2Sn$	126-129	65	Off-white	Pet.Ether
7	$(C_6F_5)_3Sn(OOC.CH_2Cl)$	$C_{20}F_{15}H_2O_2SnCl$	114-116	68	Off-white	Pet.Ether
8	$(C_6F_5)_3Sn(OOC.CHCl_2)$	$C_{20}F_{15}HO_2SnCl_2$	110-115	80	Off-white	Pet.Ether
9	$(C_6F_5)_3Sn(OOC.CCl_3)$	$C_{20}F_{15}O_2SnCl_3$	102-106	65	Off-white	Pet.Ether
10	$(C_6F_5)_3Sn(OOC.CF_3)$	$C_{20}F_{18}O_2Sn$	103-105	80	Off-white	Pet.Ether
11	$(FC_6H_4)_3Sn(OOC.CH_3)$	$C_{20}H_{15}F_3O_2Sn$	122-124	55	Off-white	Pet.Ether
12	$(FC_6H_4)_3Sn(OOC.CH_2Cl)$	$C_{20}H_{14}F_3O_2SnCl$	116-120	60	Off-white	Pet.Ether
13	$(FC_6H_4)_3Sn(OOC.CHCl_2)$	$C_{20}H_{13}F_3O_2SnCl_2$	115-117	65	Off-white	Pet.Ether
14	$(FC_6H_4)_3Sn(OOC.CCl_3)$	$C_{20}H_{12}F_3O_2SnCl_3$	110-115	65	white	Pet.Ether
15	$(FC_6H_4)_3Sn(OOC.CF_3)$	$C_{20}H_{12}F_6O_2Sn$	108-110	75	Off-white	Pet.Ether

Table-2 Analytical data of triorganotin(IV)carboxylate

S.N.	Compounds	Formula	Formula Wieght	Elemental Analysis	
				C(%)	H(%)
1	$(C_6H_5)_3Sn(OOC.CH_3)$	$C_{20}H_{18}O_2Sn$	409	58.67	4.40
2	$(C_6H_5)_3Sn(OOC.CH_2Cl)$	$C_{20}H_{17}O_2SnCl$	443.5	54.11	3.83
3	$(C_6H_5)_3Sn(OOC.CHCl_2)$	$C_{20}H_{16}O_2SnCl_2$	478	50.20	3.34
4	$(C_6H_5)_3Sn(OOC.CCl_3)$	$C_{20}H_{15}O_2SnCl_3$	512.5	46.82	2.92
5	$(C_6H_5)_3Sn(OOC.CF_3)$	$C_{20}H_{15}O_2SnF_3$	463	51.83	3.23
6	$(C_6F_5)_3Sn(OOC.CH_3)$	$C_{20}F_{15}H_3O_2Sn$	679	35.34	0.44
7	$(C_6F_5)_3Sn(OOC.CH_2Cl)$	$C_{20}F_{15}H_2O_2SnCl$	713.5	33.63	0.28
8	$(C_6F_5)_3Sn(OOC.CHCl_2)$	$C_{20}F_{15}HO_2SnCl_2$	748	32.08	0.13
9	$(C_6F_5)_3Sn(OOC.CCl_3)$	$C_{20}F_{15}O_2SnCl_3$	782.5	30.69	-
10	$(C_6F_5)_3Sn(OOC.CF_3)$	$C_{20}F_{18}O_2Sn$	733	32.74	-
11	$(FC_6H_4)_3Sn(OOC.CH_3)$	$C_{20}H_{15}F_3O_2Sn$	463	51.83	3.23
12	$(FC_6H_4)_3Sn(OOC.CH_2Cl)$	$C_{20}H_{14}F_3O_2SnCl$	497.5	48.24	2.81
13	$(FC_6H_4)_3Sn(OOC.CHCl_2)$	$C_{20}H_{13}F_3O_2SnCl_2$	532	45.11	2.44
14	$(FC_6H_4)_3Sn(OOC.CCl_3)$	$C_{20}H_{12}F_3O_2SnCl_3$	566.5	42.36	2.11
15	$(FC_6H_4)_3Sn(OOC.CF_3)$	$C_{20}H_{12}F_6O_2Sn$	517	46.42	2.32

In section-B, I describe various biomedicinal studies with toxicological studies on insects using standard methods. The results are very surprising because compounds show better efficacy against different microbial strains along with insect larvae. The tables of physicochemical and biological evaluations are as follows:-

Table-3 Antitumor activity of triorganotin (IV) carboxylate

S. No.	Compounds	MCF-7 Cell No. x 10^4	EVSA-7 Cell No. x 10^4	Activity
1	$(C_6H_5)_3Sn(OOC.CH_3)$	9.19±0.92	9.29±0.88	Positive
2	$(C_6H_5)_3Sn(OOC.CH_2Cl)$	9.17 ± 0.90	8.6 7 ± 0.69	Positive
3	$(C_6H_5)_3Sn(OOC.CHCl_2)$	11.59±1.06	11.29±1.02	Negative
4	$(C_6H_5)_3Sn(OOC.CCl_3)$	9.29±0.88	9.89±0.92	Positive
5	$(C_6H_5)_3Sn(OOC.CF_3)$	8.95±0.67	8.55±0.62	Positive
6	$(C_6F_5)_3Sn(OOC.CH_3)$	8.79 ± 0.52	8.42 ± 0.46	Positive
7	$(C_6F_5)_3Sn(OOC.CH_2Cl)$	11.52±1.02	11.82±1.06	Negative
8	$(C_6F_5)_3Sn(OOC.CHCl_2)$	9.19±0.92	9.29±0.88	Positive
9	$(C_6F_5)_3Sn(OOC.CCl_3)$	12.31±1.02	12.39±1.03	Negative
10	$(C_6F_5)_3Sn(OOC.CF_3)$	8.79 ± 0.52	8.42 ± 0.46	Positive
11	$(FC_6H_4)_3Sn(OOC.CH_3)$	9.19±0.92	9.29±0.88	Positive
12	$(FC_6H_4)_3Sn(OOC.CH_2Cl)$	8.95±0.67	8.55±0.62	Positive
13	$(FC_6H_4)_3Sn(OOC.CHCl_2)$	12.79±1.20	12.69±1.16	Negative
14	$(FC_6H_4)_3Sn(OOC.CCl_3)$	11.52±1.02	11.82±1.06	Negative
15	$(FC_6H_4)_3Sn(OOC.CF_3)$	9.19±0.92	9.29±0.88	Positive
16	Negative control	10.21±1.01	10.22±1.01	–
17	Positive control	40.26±3.23	41.23±3.28	–

Table-4: Antibacterial Activity of triorganotin (IV) carboxylate

S. N.	Compounds	Control	*Pseudomonas aeruginosa*	*Staphylococcus aureus*	*Klebsiela pneumoniae*
1	$(C_6H_5)_3Sn(OOC.CH_3)$	–	+++	+++	++
2	$(C_6H_5)_3Sn(OOC.CH_2Cl)$	–	++	++	++
3	$(C_6H_5)_3Sn(OOC.CHCl_2)$	–	++	++	++
4	$(C_6H_5)_3Sn(OOC.CCl_3)$	–	++	++	++
5	$(C_6H_5)_3Sn(OOC.CF_3)$	–	++	++	+++
6	$(C_6F_5)_3Sn(OOC.CH_3)$	–	+++	++	++
7	$(C_6F_5)_3Sn(OOC.CH_2Cl)$	–	++	++	++
8	$(C_6F_5)_3Sn(OOC.CHCl_2)$	–	++	++	+++
9	$(C_6F_5)_3Sn(OOC.CCl_3)$	–	+	+++	++
10	$(C_6F_5)_3Sn(OOC.CF_3)$	–	+++	++	++
11	$(FC_6H_4)_3Sn(OOC.CH_3)$	–	++	+	++
12	$(FC_6H_4)_3Sn(OOC.CH_2Cl)$	–	++	++	++
13	$(FC_6H_4)_3Sn(OOC.CHCl_2)$	–	+	++	+
14	$(FC_6H_4)_3Sn(OOC.CCl_3)$	–	+++	+	++
15	$(FC_6H_4)_3Sn(OOC.CF_3)$	–	++	++	++

+ = 6-10 mm; ++ = 10-14 mm; +++= >14 mm; – = Inactive

Table-5: Antifungal Activity of triorganotin (IV) carboxylate at 50 µg/ml conc.

S. N.	Compounds	*Aspergillus flavus* Col. Dia. (mm)	% Inhibition	*Aspergillus niger* Col. Dia. (mm)	% Inhibition
1	$(C_6H_5)_3Sn(OOC.CH_3)$	0.2	93.3	0.7	65.0
2	$(C_6H_5)_3Sn(OOC.CH_2Cl)$	0.2	93.3	0.7	65.0
3	$(C_6H_5)_3Sn(OOC.CHCl_2)$	0.4	86.7	0.6	70.0
4	$(C_6H_5)_3Sn(OOC.CCl_3)$	0.7	76.6	0.6	70.0
5	$(C_6H_5)_3Sn(OOC.CF_3)$	0.2	93.3	0.7	65.0
6	$(C_6F_5)_3Sn(OOC.CH_3)$	0.2	93.3	0.7	65.0
7	$(C_6F_5)_3Sn(OOC.CH_2Cl)$	0.7	76.6	0.7	65.0
8	$(C_6F_5)_3Sn(OOC.CHCl_2)$	0.8	73.3	0.8	60.0
9	$(C_6F_5)_3Sn(OOC.CCl_3)$	0.8	73.3	0.8	60.0
10	$(C_6F_5)_3Sn(OOC.CF_3)$	0.7	76.6	0.6	70.0
11	$(FC_6H_4)_3Sn(OOC.CH_3)$	0.7	76.6	0.5	75.0
12	$(FC_6H_4)_3Sn(OOC.CH_2Cl)$	0.5	83.3	0.4	80.0
13	$(FC_6H_4)_3Sn(OOC.CHCl_2)$	0.5	83.3	0.4	80.0
14	$(FC_6H_4)_3Sn(OOC.CCl_3)$	0.6	80.0	0.7	65.0
15	$(FC_6H_4)_3Sn(OOC.CF_3)$	0.7	76.6	0.7	65.0
16	Control	3.0	–	2.0	–

Table-6: Antifungal Activity of triorganotin (IV) carboxylate at 100 μg/ml conc.

S. N.	Compounds	*Aspergillus flavus* Col. Dia. (mm)	% Inhibition	*Aspergillus niger* Col. Dia. (mm)	% Inhibition
1	$(C_6H_5)_3Sn(OOC.CH_3)$	0.1	96.7	0.4	80.0
2	$(C_6H_5)_3Sn(OOC.CH_2Cl)$	0.2	93.3	0.3	75.0
3	$(C_6H_5)_3Sn(OOC.CHCl_2)$	0.1	96.7	0.3	75.0
4	$(C_6H_5)_3Sn(OOC.CCl_3)$	0.1	96.7	0.1	95.0
5	$(C_6H_5)_3Sn(OOC.CF_3)$	0.2	93.3	0.3	85.0
6	$(C_6F_5)_3Sn(OOC.CH_3)$	0.1	96.7	0.3	75.0
7	$(C_6F_5)_3Sn(OOC.CH_2Cl)$	0.2	93.3	0.3	75.0
8	$(C_6F_5)_3Sn(OOC.CHCl_2)$	0.1	96.7	0.2	90.0
9	$(C_6F_5)_3Sn(OOC.CCl_3)$	0.2	93.3	0.1	95.0
10	$(C_6F_5)_3Sn(OOC.CF_3)$	0.1	96.7	0.1	95.0
11	$(FC_6H_4)_3Sn(OOC.CH_3)$	0.4	86.7	0.2	90.0
12	$(FC_6H_4)_3Sn(OOC.CH_2Cl)$	0.2	93.3	0.2	90.0
13	$(FC_6H_4)_3Sn(OOC.CHCl_2)$	0.1	96.7	0.4	80.0
14	$(FC_6H_4)_3Sn(OOC.CCl_3)$	0.1	96.7	0.2	90.0
15	$(FC_6H_4)_3Sn(OOC.CF_3)$	0.2	93.3	0.3	85.0
16	Control	3.0	–	2.0	–

Table-7: Contact Toxicity of triorganotin (IV) carboxylate

S. N.	Compounds	Fiducial limits	Slop ± S.E.	Chi. Square	LC_{50}/LD_{50} at 24 hrs.
1	$(C_6H_5)_3Sn(OOC.CH_3)$	1.61-9.30	1.07±0.17	0.67 (3)	2.83
2	$(C_6H_5)_3Sn(OOC.CH_2Cl)$	0.72-1.46	1.71±0.18	3.32 (3)	0.97
3	$(C_6H_5)_3Sn(OOC.CHCl_2)$	1.87-12.07	1.09±0.19	1.63 (3)	3.52
4	$(C_6H_5)_3Sn(OOC.CCl_3)$	0.56-1.05	1.32±0.15	0.63 (3)	0.73
5	$(C_6H_5)_3Sn(OOC.CF_3)$	0.43-0.75	1.63±0.6	2.94 (3)	0.58
6	$(C_6F_5)_3Sn(OOC.CH_3)$	1.42-3.89	1.32±0.16	2.37 (3)	2.12
7	$(C_6F_5)_3Sn(OOC.CH_2Cl)$	1.87-12.07	1.09±0.19	1.62 (3)	3.53
8	$(C_6F_5)_3Sn(OOC.CHCl_2)$	1.57-9.32	1.07±0.17	0.72 (3)	2.83
9	$(C_6F_5)_3Sn(OOC.CCl_3)$	0.28-0.40	1.96±0.16	4.39 (3)	0.33
10	$(C_6F_5)_3Sn(OOC.CF_3)$	0.39-0.59	1.67±0.15	5.62 (3)	0.46
11	$(FC_6H_4)_3Sn(OOC.CH_3)$	1.87-12.07	1.09±0.19	1.63 (3)	3.52
12	$(FC_6H_4)_3Sn(OOC.CH_2Cl)$	0.56-1.05	1.32±0.15	0.63 (3)	0.73
13	$(FC_6H_4)_3Sn(OOC.CHCl_2)$	1.42-3.89	1.32±0.16	2.37 (3)	2.12
14	$(FC_6H_4)_3Sn(OOC.CCl_3)$	0.72-1.46	1.71±0.18	3.32 (3)	0.97
15	$(FC_6H_4)_3Sn(OOC.CF_3)$	1.87-12.07	1.09±0.19	1.63 (3)	3.52

Table-8: Stomach Toxicity of triorganotin (IV) carboxylate

S. N.	Compounds	Fiducial limits	Slop ± S.E.	Chi. Square	LC_{50}/LD_{50} at 24 hrs.
1	$(C_6H_5)_3Sn(OOC.CH_3)$	0.74-1.32	1.62±0.18	3.24 (3)	0.94
2	$(C_6H_5)_3Sn(OOC.CH_2Cl)$	0.85-1.82	1.22±0.16	0.72 (3)	1.12
3	$(C_6H_5)_3Sn(OOC.CHCl_2)$	0.55-0.97	1.32±0.15	0.69 (3)	0.73
4	$(C_6H_5)_3Sn(OOC.CCl_3)$	1.33-3.99	1.42±0.20	2.38 (3)	2.01
5	$(C_6H_5)_3Sn(OOC.CF_3)$	0.55-0.90	1.48±0.16	3.37 (3)	0.67
6	$(C_6F_5)_3Sn(OOC.CH_3)$	0.56-0.97	1.33±0.15	0.63 (3)	0.75
7	$(C_6F_5)_3Sn(OOC.CH_2Cl)$	0.55-0.97	1.32±0.15	0.69 (3)	0.73
8	$(C_6F_5)_3Sn(OOC.CHCl_2)$	1.61-9.55	1.45±0.17	0.68 (3)	2.97
9	$(C_6F_5)_3Sn(OOC.CCl_3)$	0.86-1.99	1.28±0.16	0.80 (3)	1.20
10	$(C_6F_5)_3Sn(OOC.CF_3)$	0.49-0.76	1.57±0.16	2.78 (3)	0.60
11	$(FC_6H_4)_3Sn(OOC.CH_3)$	0.55-0.90	1.48±0.16	3.37 (3)	0.67
12	$(FC_6H_4)_3Sn(OOC.CH_2Cl)$	0.56-0.97	1.33±0.15	0.63 (3)	0.75
13	$(FC_6H_4)_3Sn(OOC.CHCl_2)$	0.85-1.82	1.22±0.16	0.72 (3)	1.12
14	$(FC_6H_4)_3Sn(OOC.CCl_3)$	1.33-3.99	1.42±0.20	2.38 (3)	2.01
15	$(FC_6H_4)_3Sn(OOC.CF_3)$	1.62-9.39	1.01±0.17	0.69 (3)	2.93

Table-9: Antifeedant Toxicity of triorganotin (IV) carboxylate

S. N.	Compounds	Fiducial limits	Slop ± S.E.	Chi. Square	LC_{50}/LD_{50} at 24 hrs.

1	$(C_6H_5)_3Sn(OOC.CH_3)$	0.45-1.09	0.87±0.13	1.71 (3)	0.64
2	$(C_6H_5)_3Sn(OOC.CH_2Cl)$	0.49-0.76	1.52±0.16	2.59 (3)	0.58
3	$(C_6H_5)_3Sn(OOC.CHCl_2)$	0.72-2.41	0.93±0.14	0.22 (3)	1.13
4	$(C_6H_5)_3Sn(OOC.CCl_3)$	0.30-0.47	1.28±0.14	3.42 (3)	0.39
5	$(C_6H_5)_3Sn(OOC.CF_3)$	0.33-0.61	1.00±0.13	0.68 (3)	0.43
6	$(C_6F_5)_3Sn(OOC.CH_3)$	0.83-2.33	1.08±0.15	0.79 (3)	1.24
7	$(C_6F_5)_3Sn(OOC.CH_2Cl)$	0.30-0.47	1.28±0.14	3.42 (3)	0.39
8	$(C_6F_5)_3Sn(OOC.CHCl_2)$	0.33-0.61	1.00±0.13	0.68 (3)	0.43
9	$(C_6F_5)_3Sn(OOC.CCl_3)$	0.33-0.61	1.00±0.13	0.68 (3)	0.43
10	$(C_6F_5)_3Sn(OOC.CF_3)$	0.82-3.41	1.81±0.14	0.43 (3)	1.35
11	$(FC_6H_4)_3Sn(OOC.CH_3)$	0.68-1.72	1.03±0.14	0.66 (3)	0.98
12	$(FC_6H_4)_3Sn(OOC.CH_2Cl)$	0.43-0.87	1.03±0.14	0.34 (3)	0.58
13	$(FC_6H_4)_3Sn(OOC.CHCl_2)$	0.62-1.42	1.06±0.14	1.07 (3)	0.86
14	$(FC_6H_4)_3Sn(OOC.CCl_3)$	0.83-2.33	1.08±0.15	0.79 (3)	1.24
15	$(FC_6H_4)_3Sn(OOC.CF_3)$	0.72-2.41	0.93±0.14	0.22 (3)	1.13

Table-10: Acaricidal Toxicity of triorganotin (IV) carboxylate

S. N.	Compounds	Fiducial limits	Slop ± S.E.	Chi. Square	LC_{50}/LD_{50} at 24 hrs.
1	$(C_6H_5)_3Sn(OOC.CH_3)$	0.08-0.23	0.65±0.07	6.12 (3)	0.13

2	$(C_6H_5)_3Sn(OOC.CH_2Cl)$	0.05-0.10	0.97±0.07	13.23 (3)	0.07
3	$(C_6H_5)_3Sn(OOC.CHCl_2)$	0.07-0.22	0.76±0.06	5.63 (3)	0.14
4	$(C_6H_5)_3Sn(OOC.CCl_3)$	0.05-0.10	0.78±.0.06	4.64 (3)	0.06
5	$(C_6H_5)_3Sn(OOC.CF_3)$	0.10-0.23	0.88±0.08	2.14 (3)	0.15
6	$(C_6F_5)_3Sn(OOC.CH_3)$	0.07-0.22	0.76±0.06	5.63 (3)	0.14
7	$(C_6F_5)_3Sn(OOC.CH_2Cl)$	0.05-0.10	0.78±.0.06	4.64 (3)	0.06
8	$(C_6F_5)_3Sn(OOC.CHCl_2)$	0.10-0.23	0.88±0.08	2.14 (3)	0.15
9	$(C_6F_5)_3Sn(OOC.CCl_3)$	0.05-0.09	0.16±0.09	12.67 (3)	0.07
10	$(C_6F_5)_3Sn(OOC.CF_3)$	0.14-0.31	0.96±0.09	7.52 (3)	0.20
11	$(FC_6H_4)_3Sn(OOC.CH_3)$	0.12-0.30	0.78±0.08	1.70 (3)	0.18
12	$(FC_6H_4)_3Sn(OOC.CH_2Cl)$	0.14-0.31	0.96±0.09	7.52 (3)	0.20
13	$(FC_6H_4)_3Sn(OOC.CHCl_2)$	0.05-0.10	0.93±0.08	13.22 (3)	0.06
14	$(FC_6H_4)_3Sn(OOC.CCl_3)$	0.04-0.09	0.69±0.06	4.64 (3)	0.05
15	$(FC_6H_4)_3Sn(OOC.CF_3)$	0.05-0.09	0.16±0.09	12.67 (3)	0.07

CHAPTER-7

This Chapter is also compiled in two sections, section-A which deals the synthesis of diorganotin (IV) dicarboxylates and their characterization using different experimental techniques. The compounds were synthesized by using the suitable diorganotin (IV) dihalide and respective carboxylic acid in presence of triethylamine at room temperature for about 4-5 hours. The $Et_3N.HCl$ formed would be filtered off and the filtrate on concentration in vacuum gave crystalline solid, which was recrystallised from petroleum ether (40-60^{o}C).

$$R_2SnCl_2 + 2HL \xrightarrow{Et_3N} R_2SnL_2 + 2Et_3N.HCl$$

HL = Carboxylic acids

All the newly synthesized compounds were crystalline solids, air stable and soluble in common organic solvents. The compounds were further characterized by using analytical techniques such as elemental and spectral analysis.

Section-B of this chapter describes various biomedicinal studies along with toxicological studies on insects using standard methods. The results are very surprising because compounds show better efficacy against different microbial strains along with insect larvae. The tables of physicochemical and biological evaluations are as follows:-

Table-1 Physicochemical Properties of diorganotin(IV)dicarboxylates

S.N.	Compounds	Formula	M.P (°C)	Yield (%)	Color	Solvent
1	$(C_6H_5)_2Sn(OOC.CH_3)_2$	$C_{16}H_{16}O_4Sn$	186	65	Off-white	Pet.Ether
2	$(C_6H_5)_2Sn(OOC.CH_2Cl)_2$	$C_{16}H_{14}O_4SnCl_2$	178	68	Off-white	Pet.Ether
3	$(C_6H_5)_2Sn(OOC.CHCl_2)_2$	$C_{16}H_{12}O_4SnCl_4$	182	80	Off-white	Pet.Ether
4	$(C_6H_5)_2Sn(OOC.CCl_3)_2$	$C_{16}H_{10}O_4SnCl_6$	180	75	Off-white	Pet.Ether
5	$(C_6H_5)_2Sn(OOC.CF_3)_2$	$C_{16}H_{10}O_4SnF_6$	162	65	Off-white	Pet.Ether
6	$(C_6F_5)_2Sn(OOC.CH_3)_2$	$C_{16}F_{10}H_6O_4Sn$	176	80	Off-white	Pet.Ether
7	$(C_6F_5)_2Sn(OOC.CH_2Cl)_2$	$C_{16}F_{10}H_4O_4Sn\ Cl_2$	166	55	Off-white	Pet.Ether
8	$(C_6F_5)_2Sn(OOC.CHCl_2)_2$	$C_{16}F_{10}H_2O_4Sn\ Cl_4$	162	60	Off-white	Pet.Ether
9	$(C_6F_5)_2Sn(OOC.CCl_3)_2$	$C_{16}F_{10}O_4Sn\ Cl_6$	160	62	Off-white	Pet.Ether
10	$(C_6F_5)_2Sn(OOC.CF_3)_2$	$C_{16}F_{16}O_4Sn$	158	65	Off-white	Pet.Ether
11	$(FC_6H_4)_2Sn(OOC.CH_3)_2$	$C_{16}H_{14}F_2O_4Sn$	182	70	Off-white	Pet.Ether
12	$(FC_6H_4)_2Sn(OOC.CH_2Cl)_2$	$C_{16}H_{12}F_2O_4SnCl_2$	172	75	Off-white	Pet.Ether
13	$(FC_6H_4)_2Sn(OOC.CHCl_2)_2$	$C_{16}H_{10}F_2O_4SnCl_4$	177	65	Off-white	Pet.Ether
14	$(FC_6H_4)_2Sn(OOC.CCl_3)_2$	$C_{16}H_8F_2O_4SnCl_6$	166	82	Off-white	Pet.Ether
15	$(FC_6H_4)_2Sn(OOC.CF_3)_2$	$C_{16}H_8F_8O_4Sn$	163	65	Off-white	Pet.Ether

Table-2 Analytical data of diorganotin(IV)dicarboxylates

S.N.	Compounds	Formula	Formula Wieght	Elemental Analysis	
				C(%)	H(%)
1	$(C_6H_5)_2Sn(OOC.CH_3)_2$	$C_{16}H_{16}O_4Sn$	391	49.10	4.09
2	$(C_6H_5)_2Sn(OOC.CH_2Cl)_2$	$C_{16}H_{14}O_4SnCl_2$	460	41.73	3.04
3	$(C_6H_5)_2Sn(OOC.CHCl_2)_2$	$C_{16}H_{12}O_4SnCl_4$	529	36.29	2.26
4	$(C_6H_5)_2Sn(OOC.CCl_3)_2$	$C_{16}H_{10}O_4SnCl_6$	598	32.10	1.67
5	$(C_6H_5)_2Sn(OOC.CF_3)_2$	$C_{16}H_{10}O_4SnF_6$	499	38.47	2.00
6	$(C_6F_5)_2Sn(OOC.CH_3)_2$	$C_{16}F_{10}H_6O_4Sn$	571	33.62	1.05
7	$(C_6F_5)_2Sn(OOC.CH_2Cl)_2$	$C_{16}F_{10}H_4O_4Sn Cl_2$	640	30.00	0.62
8	$(C_6F_5)_2Sn(OOC.CHCl_2)_2$	$C_{16}F_{10}H_2O_4Sn Cl_4$	709	27.08	0.28
9	$(C_6F_5)_2Sn(OOC.CCl_3)_2$	$C_{16}F_{10}O_4Sn Cl_6$	778	24.67	-
10	$(C_6F_5)_2Sn(OOC.CF_3)_2$	$C_{16}F_{16}O_4Sn$	679	28.27	-
11	$(FC_6H_4)_2Sn(OOC.CH_3)_2$	$C_{16}H_{14}F_2O_4Sn$	427	44.96	3.27
12	$(FC_6H_4)_2Sn(OOC.CH_2Cl)_2$	$C_{16}H_{12}F_2O_4SnCl_2$	496	38.70	2.41
13	$(FC_6H_4)_2Sn(OOC.CHCl_2)_2$	$C_{16}H_{10}F_2O_4SnCl_4$	565	33.98	1.76
14	$(FC_6H_4)_2Sn(OOC.CCl_3)_2$	$C_{16}H_8F_2O_4SnCl_6$	634	30.28	1.26
15	$(FC_6H_4)_2Sn(OOC.CF_3)_2$	$C_{16}H_8F_8O_4Sn$	535	35.88	1.49

Table-3 Antitumor activity of diorganotin (IV) dicarboxylate

S. No.	Compounds	MCF-7 Cell No. x 10^4	EVSA-7 Cell No. x 10^4	Activity
1	$(C_6H_5)_2Sn(OOC.CH_3)_2$	11.69 ± 1.04	11.82 ± 1.06	Negative
2	$(C_6H_5)_2Sn(OOC.CH_2Cl)_2$	9.17 ± 0.90	8.6 7 ± 0.69	Positive
3	$(C_6H_5)_2Sn(OOC.CHCl_2)_2$	8.79 ± 0.52	8.42 ± 0.46	Positive
4	$(C_6H_5)_2Sn(OOC.CCl_3)_2$	12.31±1.02	12.39±1.03	Negative
5	$(C_6H_5)_2Sn(OOC.CF_3)_2$	8.95±0.67	8.55±0.62	Positive
6	$(C_6F_5)_2Sn(OOC.CH_3)_2$	11.59±1.06	11.29±1.02	Negative
7	$(C_6F_5)_2Sn(OOC.CH_2Cl)_2$	9.29±0.88	9.89±0.92	Positive
8	$(C_6F_5)_2Sn(OOC.CHCl_2)_2$	12.79±1.20	12.69±1.16	Negative
9	$(C_6F_5)_2Sn(OOC.CCl_3)_2$	11.52±1.02	11.82±1.06	Negative
10	$(C_6F_5)_2Sn(OOC.CF_3)_2$	9.19±0.92	9.29±0.88	Positive
11	$(FC_6H_4)_2Sn(OOC.CH_3)_2$	9.17 ± 0.90	8.6 7 ± 0.69	Positive
12	$(FC_6H_4)_2Sn(OOC.CH_2Cl)_2$	8.95±0.67	8.55±0.62	Positive
13	$(FC_6H_4)_2Sn(OOC.CHCl_2)_2$	8.79 ± 0.52	8.42 ± 0.46	Positive
14	$(FC_6H_4)_2Sn(OOC.CCl_3)_2$	11.52±1.02	11.82±1.06	Negative
15	$(FC_6H_4)_2Sn(OOC.CF_3)_2$	9.19±0.92	9.29±0.88	Positive
16	Negative control	10.21±1.01	10.22±1.01	–
17	Positive control	40.26±3.23	41.23±3.28	–

Table-4: Antibacterial Activity of diorganotin (IV) dicarboxylate

S. N.	Compounds	Control	*Pseudomonas aeruginosa*	*Staphylococcus aureus*	*Klebsiela pneumoniae*
1	$(C_6H_5)_2Sn(OOC.CH_3)_2$	–	+++	++	++
2	$(C_6H_5)_2Sn(OOC.CH_2Cl)_2$	–	++	+	++
3	$(C_6H_5)_2Sn(OOC.CHCl_2)_2$	–	++	+	++
4	$(C_6H_5)_2Sn(OOC.CCl_3)_2$	–	++	++	++
5	$(C_6H_5)_2Sn(OOC.CF_3)_2$	–	+	++	+
6	$(C_6F_5)_2Sn(OOC.CH_3)_2$	–	+++	+	++
7	$(C_6F_5)_2Sn(OOC.CH_2Cl)_2$	–	++	+	++
8	$(C_6F_5)_2Sn(OOC.CHCl_2)_2$	–	++	+	+++
9	$(C_6F_5)_2Sn(OOC.CCl_3)_2$	–	+	+++	++
10	$(C_6F_5)_2Sn(OOC.CF_3)_2$	–	+++	++	++
11	$(FC_6H_4)_2Sn(OOC.CH_3)_2$	–	++	+	++
12	$(FC_6H_4)_2Sn(OOC.CH_2Cl)_2$	–	++	++	++
13	$(FC_6H_4)_2Sn(OOC.CHCl_2)_2$	–	+	++	+
14	$(FC_6H_4)_2Sn(OOC.CCl_3)_2$	–	+++	+	++
15	$(FC_6H_4)_2Sn(OOC.CF_3)_2$	–	++	+	++

+ = 6-10 mm; ++ = 10-14 mm; +++= >14 mm; – = Inactive

Table-5: Antifungal Activity of diorganotin (IV) dicarboxylate at 50 μg/ml conc.

S. N.	Compounds	*Aspergillus flavus* Col. Dia. (mm)	% Inhibition	*Aspergillus niger* Col. Dia. (mm)	% Inhibition
1	$(C_6H_5)_2Sn(OOC.CH_3)_2$	0.7	76.6	0.5	75.0
2	$(C_6H_5)_2Sn(OOC.CH_2Cl)_2$	0.5	83.3	0.4	80.0
3	$(C_6H_5)_2Sn(OOC.CHCl_2)_2$	0.5	83.3	0.4	80.0
4	$(C_6H_5)_2Sn(OOC.CCl_3)_2$	0.6	80.0	0.7	65.0
5	$(C_6H_5)_2Sn(OOC.CF_3)_2$	0.7	76.6	0.6	70.0
6	$(C_6F_5)_2Sn(OOC.CH_3)_2$	0.8	73.3	0.8	60.0
7	$(C_6F_5)_2Sn(OOC.CH_2Cl)_2$	0.7	76.6	0.7	65.0
8	$(C_6F_5)_2Sn(OOC.CHCl_2)_2$	0.2	93.3	0.7	65.0
9	$(C_6F_5)_2Sn(OOC.CCl_3)_2$	0.2	93.3	0.7	65.0
10	$(C_6F_5)_2Sn(OOC.CF_3)_2$	0.4	86.7	0.6	70.0
11	$(FC_6H_4)_2Sn(OOC.CH_3)_2$	0.7	76.6	0.6	70.0
12	$(FC_6H_4)_2Sn(OOC.CH_2Cl)_2$	0.8	73.3	0.8	60.0
13	$(FC_6H_4)_2Sn(OOC.CHCl_2)_2$	0.7	76.6	0.7	65.0
14	$(FC_6H_4)_2Sn(OOC.CCl_3)_2$	0.2	93.3	0.7	65.0
15	$(FC_6H_4)_2Sn(OOC.CF_3)_2$	0.2	93.3	0.7	65.0
16	Control	3.0	–	2.0	–

Table-6: Antifungal Activity of diorganotin (IV) dicarboxylate at 100 μg/ml conc.

S. N.	Compounds	*Aspergillus flavus* Col. Dia. (mm)	% Inhibition	*Aspergillus niger* Col. Dia. (mm)	% Inhibition
1	$(C_6H_5)_2Sn(OOC.CH_3)_2$	0.1	96.7	0.2	90.0
2	$(C_6H_5)_2Sn(OOC.CH_2Cl)_2$	0.2	93.3	0.1	95.0
3	$(C_6H_5)_2Sn(OOC.CHCl_2)_2$	0.1	96.7	0.1	95.0
4	$(C_6H_5)_2Sn(OOC.CCl_3)_2$	0.4	86.7	0.2	90.0
5	$(C_6H_5)_2Sn(OOC.CF_3)_2$	0.2	93.3	0.2	90.0
6	$(C_6F_5)_2Sn(OOC.CH_3)_2$	0.1	96.7	0.4	80.0
7	$(C_6F_5)_2Sn(OOC.CH_2Cl)_2$	0.2	93.3	0.3	75.0
8	$(C_6F_5)_2Sn(OOC.CHCl_2)_2$	0.1	96.7	0.3	75.0
9	$(C_6F_5)_2Sn(OOC.CCl_3)_2$	0.1	96.7	0.2	90.0
10	$(C_6F_5)_2Sn(OOC.CF_3)_2$	0.2	93.3	0.3	85.0
11	$(FC_6H_4)_2Sn(OOC.CH_3)_2$	0.1	96.7	0.4	80.0
12	$(FC_6H_4)_2Sn(OOC.CH_2Cl)_2$	0.2	93.3	0.3	75.0
13	$(FC_6H_4)_2Sn(OOC.CHCl_2)_2$	0.1	96.7	0.3	75.0
14	$(FC_6H_4)_2Sn(OOC.CCl_3)_2$	0.1	96.7	0.1	95.0
15	$(FC_6H_4)_2Sn(OOC.CF_3)_2$	0.2	93.3	0.3	85.0
16	Control	3.0	–	2.0	–

Table-7: Contact Toxicity of diorganotin (IV) dicarboxylate

S. N.	Compounds	Fiducial limits	Slop ± S.E.	Chi. Square	LC_{50}/LD_{50} at 24 hrs.
1	$(C_6H_5)_2Sn(OOC.CH_3)_2$	1.87-12.07	1.09±0.19	1.62 (3)	3.53
2	$(C_6H_5)_2Sn(OOC.CH_2Cl)_2$	1.57-9.32	1.07±0.17	0.72 (3)	2.83
3	$(C_6H_5)_2Sn(OOC.CHCl_2)_2$	0.28-0.40	1.96±0.16	4.39 (3)	0.33
4	$(C_6H_5)_2Sn(OOC.CCl_3)_2$	0.39-0.59	1.67±0.15	5.62 (3)	0.46
5	$(C_6H_5)_2Sn(OOC.CF_3)_2$	0.43-0.75	1.63±0.6	2.94 (3)	0.58
6	$(C_6F_5)_2Sn(OOC.CH_3)_2$	1.87-12.07	1.09±0.19	1.63 (3)	3.52
7	$(C_6F_5)_2Sn(OOC.CH_2Cl)_2$	0.56-1.05	1.32±0.15	0.63 (3)	0.73
8	$(C_6F_5)_2Sn(OOC.CHCl_2)_2$	1.42-3.89	1.32±0.16	2.37 (3)	2.12
9	$(C_6F_5)_2Sn(OOC.CCl_3)_2$	1.61-9.30	1.07±0.17	0.67 (3)	2.83
10	$(C_6F_5)_2Sn(OOC.CF_3)_2$	0.72-1.46	1.71±0.18	3.32 (3)	0.97
11	$(FC_6H_4)_2Sn(OOC.CH_3)_2$	1.87-12.07	1.09±0.19	1.63 (3)	3.52
12	$(FC_6H_4)_2Sn(OOC.CH_2Cl)_2$	0.56-1.05	1.32±0.15	0.63 (3)	0.73
13	$(FC_6H_4)_2Sn(OOC.CHCl_2)_2$	1.42-3.89	1.32±0.16	2.37 (3)	2.12
14	$(FC_6H_4)_2Sn(OOC.CCl_3)_2$	0.72-1.46	1.71±0.18	3.32 (3)	0.97
15	$(FC_6H_4)_2Sn(OOC.CF_3)_2$	1.87-12.07	1.09±0.19	1.63 (3)	3.52

Table-8: Stomach Toxicity of diorganotin (IV) dicarboxylate

S. N.	Compounds	Fiducial limits	Slop ± S.E.	Chi. Square	LC_{50}/LD_{50} at 24 hrs.
1	$(C_6H_5)_2Sn(OOC.CH_3)_2$	1.61-9.55	1.45±0.17	0.68 (3)	2.97
2	$(C_6H_5)_2Sn(OOC.CH_2Cl)_2$	0.86-1.99	1.28±0.16	0.80 (3)	1.20
3	$(C_6H_5)_2Sn(OOC.CHCl_2)_2$	0.49-0.76	1.57±0.16	2.78 (3)	0.60
4	$(C_6H_5)_2Sn(OOC.CCl_3)_2$	0.55-0.90	1.48±0.16	3.37 (3)	0.67
5	$(C_6H_5)_2Sn(OOC.CF_3)_2$	0.56-0.97	1.33±0.15	0.63 (3)	0.75
6	$(C_6F_5)_2Sn(OOC.CH_3)_2$	0.85-1.82	1.22±0.16	0.72 (3)	1.12
7	$(C_6F_5)_2Sn(OOC.CH_2Cl)_2$	0.55-0.97	1.32±0.15	0.69 (3)	0.73
8	$(C_6F_5)_2Sn(OOC.CHCl_2)_2$	1.33-3.99	1.42±0.20	2.38 (3)	2.01
9	$(C_6F_5)_2Sn(OOC.CCl_3)_2$	1.62-9.39	1.01±0.17	0.69 (3)	2.93
10	$(C_6F_5)_2Sn(OOC.CF_3)_2$	0.74-1.32	1.62±0.18	3.24 (3)	0.94
11	$(FC_6H_4)_2Sn(OOC.CH_3)_2$	0.85-1.82	1.22±0.16	0.72 (3)	1.12
12	$(FC_6H_4)_2Sn(OOC.CH_2Cl)_2$	0.55-0.97	1.32±0.15	0.69 (3)	0.73
13	$(FC_6H_4)_2Sn(OOC.CHCl_2)_2$	1.33-3.99	1.42±0.20	2.38 (3)	2.01
14	$(FC_6H_4)_2Sn(OOC.CCl_3)_2$	0.55-0.90	1.48±0.16	3.37 (3)	0.67
15	$(FC_6H_4)_2Sn(OOC.CF_3)_2$	0.56-0.97	1.33±0.15	0.63 (3)	0.75

Table-9: Antifeedant Toxicity of diorganotin (IV) dicarboxylate

S. N.	Compounds	Fiducial limits	Slop ± S.E.	Chi. Square	LC_{50}/LD_{50} at 24 hrs.
1	$(C_6H_5)_2Sn(OOC.CH_3)_2$	0.82-3.41	1.81±0.14	0.43 (3)	1.35
2	$(C_6H_5)_2Sn(OOC.CH_2Cl)_2$	0.68-1.72	1.03±0.14	0.66 (3)	0.98
3	$(C_6H_5)_2Sn(OOC.CHCl_2)_2$	0.43-0.87	1.03±0.14	0.34 (3)	0.58
4	$(C_6H_5)_2Sn(OOC.CCl_3)_2$	0.62-1.42	1.06±0.14	1.07 (3)	0.86
5	$(C_6H_5)_2Sn(OOC.CF_3)_2$	0.83-2.33	1.08±0.15	0.79 (3)	1.24
6	$(C_6F_5)_2Sn(OOC.CH_3)_2$	0.72-2.41	0.93±0.14	0.22 (3)	1.13
7	$(C_6F_5)_2Sn(OOC.CH_2Cl)_2$	0.30-0.47	1.28±0.14	3.42 (3)	0.39
8	$(C_6F_5)_2Sn(OOC.CHCl_2)_2$	0.33-0.61	1.00±0.13	0.68 (3)	0.43
9	$(C_6F_5)_2Sn(OOC.CCl_3)_2$	0.45-1.09	0.87±0.13	1.71 (3)	0.64
10	$(C_6F_5)_2Sn(OOC.CF_3)_2$	0.49-0.76	1.52±0.16	2.59 (3)	0.58
11	$(FC_6H_4)_2Sn(OOC.CH_3)_2$	0.72-2.41	0.93±0.14	0.22 (3)	1.13
12	$(FC_6H_4)_2Sn(OOC.CH_2Cl)_2$	0.30-0.47	1.28±0.14	3.42 (3)	0.39
13	$(FC_6H_4)_2Sn(OOC.CHCl_2)_2$	0.33-0.61	1.00±0.13	0.68 (3)	0.43
14	$(FC_6H_4)_2Sn(OOC.CCl_3)_2$	0.83-2.33	1.08±0.15	0.79 (3)	1.24
15	$(FC_6H_4)_2Sn(OOC.CF_3)_2$	0.33-0.61	1.00±0.13	0.68 (3)	0.43

Table-10: Acaricidal Toxicity of diorganotin (IV) dicarboxylate

S. N.	Compounds	Fiducial limits	Slop ± S.E.	Chi. Square	LC_{50}/LD_{50} at 24 hrs.
1	$(C_6H_5)_2Sn(OOC.CH_3)_2$	0.12-0.30	0.78±0.08	1.70 (3)	0.18
2	$(C_6H_5)_2Sn(OOC.CH_2Cl)_2$	0.14-0.31	0.96±0.09	7.52 (3)	0.20
3	$(C_6H_5)_2Sn(OOC.CHCl_2)_2$	0.05-0.10	0.93±0.08	13.22 (3)	0.06
4	$(C_6H_5)_2Sn(OOC.CCl_3)_2$	0.04-0.09	0.69±0.06	4.64 (3)	0.05
5	$(C_6H_5)_2Sn(OOC.CF_3)_2$	0.05-0.09	0.16±0.09	12.67 (3)	0.07
6	$(C_6F_5)_2Sn(OOC.CH_3)_2$	0.07-0.22	0.76±0.06	5.63 (3)	0.14
7	$(C_6F_5)_2Sn(OOC.CH_2Cl)_2$	0.05-0.10	0.78±.0.06	4.64 (3)	0.06
8	$(C_6F_5)_2Sn(OOC.CHCl_2)_2$	0.10-0.23	0.88±0.08	2.14 (3)	0.15
9	$(C_6F_5)_2Sn(OOC.CCl_3)_2$	0.08-0.23	0.65±0.07	6.12 (3)	0.13
10	$(C_6F_5)_2Sn(OOC.CF_3)_2$	0.05-0.10	0.97±0.07	13.23 (3)	0.07
11	$(FC_6H_4)_2Sn(OOC.CH_3)_2$	0.07-0.22	0.76±0.06	5.63 (3)	0.14
12	$(FC_6H_4)_2Sn(OOC.CH_2Cl)_2$	0.05-0.10	0.78±.0.06	4.64 (3)	0.06
13	$(FC_6H_4)_2Sn(OOC.CHCl_2)_2$	0.10-0.23	0.88±0.08	2.14 (3)	0.15
14	$(FC_6H_4)_2Sn(OOC.CCl_3)_2$	0.05-0.09	0.16±0.09	12.67 (3)	0.07
15	$(FC_6H_4)_2Sn(OOC.CF_3)_2$	0.14-0.31	0.96±0.09	7.52 (3)	0.20

CHAPTER-8

This last chapter concludes the work and suggested that organotin compounds may use in medicinal and agricultural fields as potent compounds.